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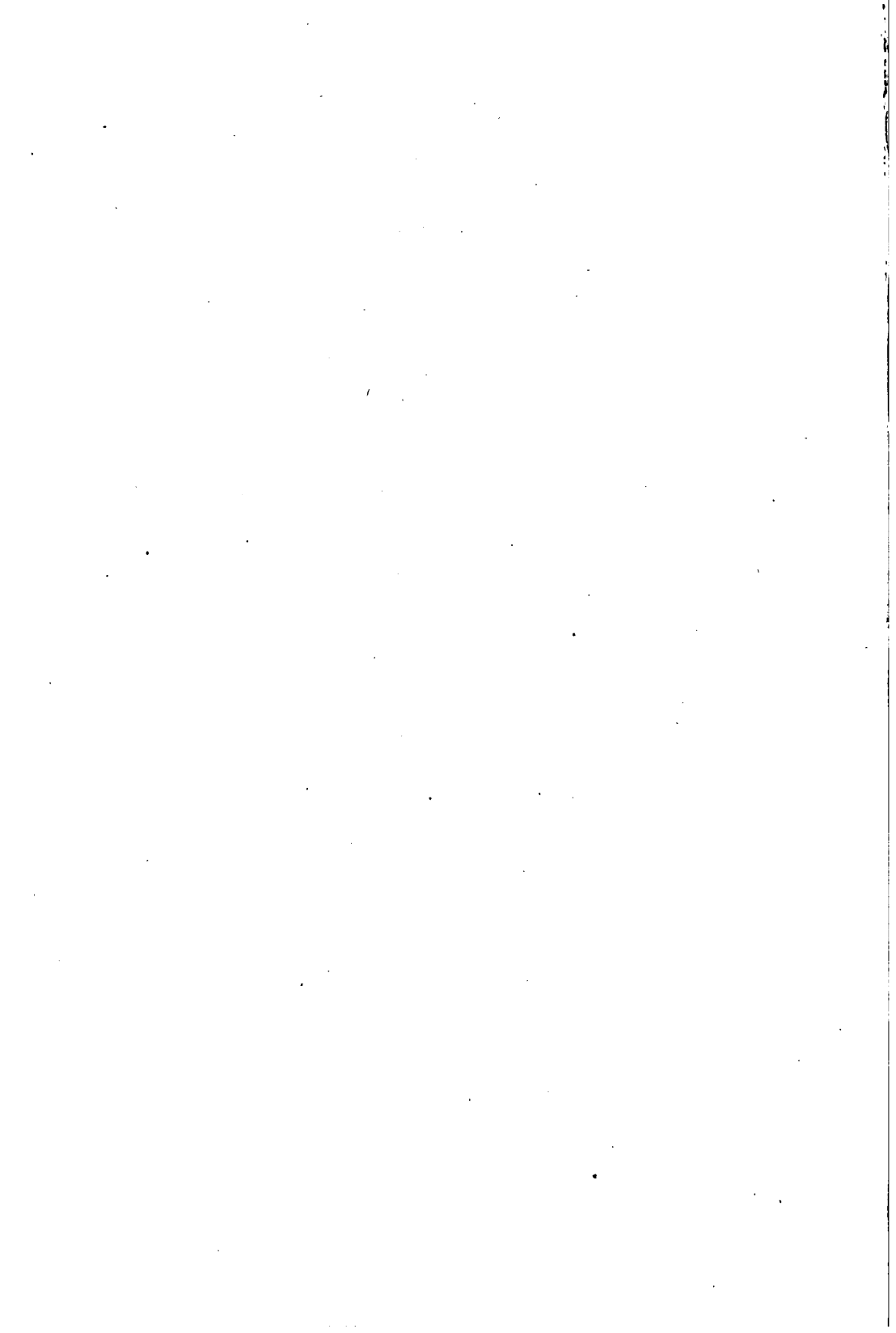
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Volume Four

Number Three

SCHOOL OF MINES AND METALLURGY

UNIVERSITY OF MISSOURI

BULLETIN

FEBRUARY, 1918

TECHNICAL SERIES

A BIBLIOGRAPHY
on the
ROASTING, LEACHING, SMELTING
and
ELECTROMETALLURGY OF ZINC

REVISED TO JUNE, 1919.

ROLLA, MISSOURI
1918

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The Experiment Station was established June 1, 1909.

It is the object of the Station to conduct such original researches or to verify such experiments as relate to the properties and uses of mineral products; to investigate the engineering problems connected with the mineral industry, the economic methods of mining and the preparation of mineral products, the methods of preventing waste of the mineral resources and the methods of preventing accidents in mines, mills, and smelters, to assist in improving the conditions surrounding the labor in mines, mills, and smelters; and such other researches or experiments as bear directly upon the application of mining and metallurgical engineering to the mineral industry of the State of Missouri.

Any resident of the State may on request obtain bulletins as issued, or if particularly interested, may be placed on the regular mailing list. Correspondence regarding these bulletins or the work of the Station may be addressed to the Director, Mining Experiment Station, Rolla, Missouri.

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SCHOOL OF MINES AND METALLURGY

UNIVERSITY OF MISSOURI

A BIBLIOGRAPHY
on the
ROASTING, LEACHING, SMELTING
and
ELECTROMETALLURGY OF ZINC

Compiled by
HAROLD L. WHEELER, A. B., B. L. S.,
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REVISED TO JUNE, 1919

ROLLA. MISSOURI
1918

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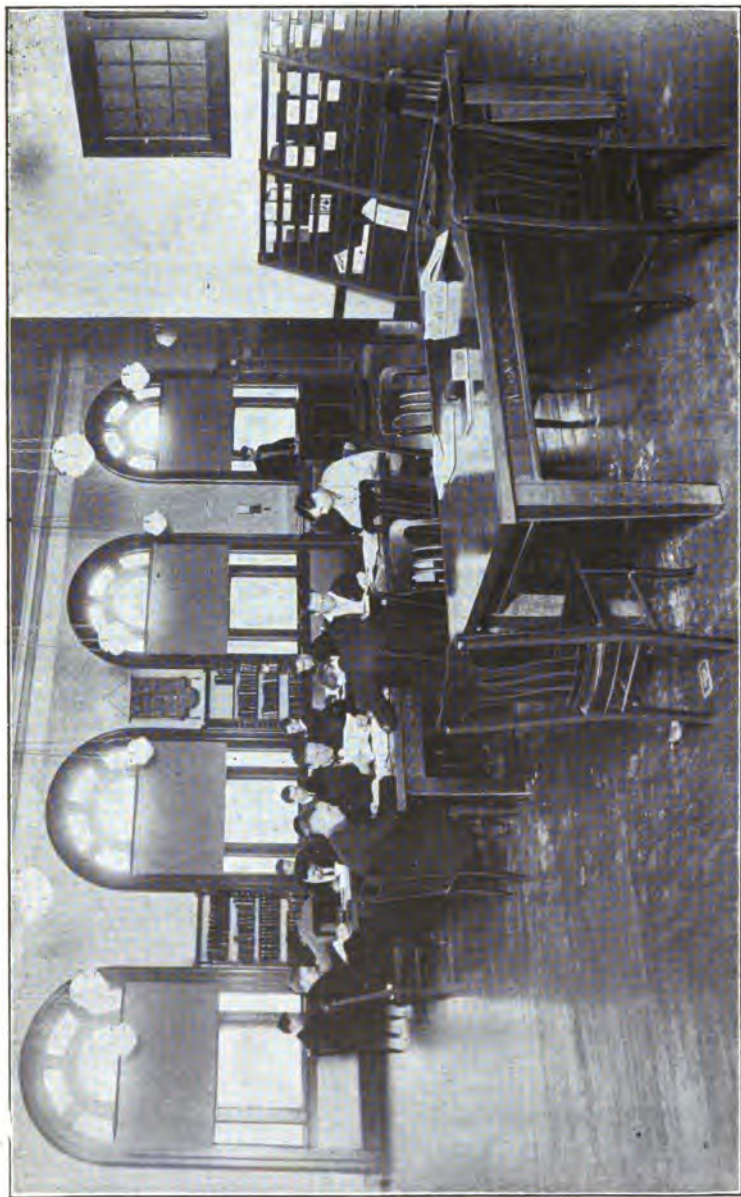
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METALLURGY AND ORE DRESSING BUILDING

PREFACE

The following list of references was compiled chiefly for the use of the instructors and students in the Metallurgy Department of the Missouri School of Mines, and is based on the collection of material in the Library of the School, although fully half its references are to material not in this Library. It is not, therefore, a complete bibliography, although the effort has been to make it as nearly so as was possible with the resources and the time available, and the compiler believes that it may be considered reasonably complete. The amount of literature on the metallurgy of zinc is enormous, especially in the case of patents. It has been the intention, therefore, to omit material of minor importance and to emphasize processes rather than apparatus. The files of foreign patents are not among the resources of this Library, and are available only through abstracts and citations in other journals. For this reason the inclusion of foreign patents is especially incomplete.

In the case of the United States patents, the descriptive annotations are quoted from the patent claims as printed in the official Patent Office Gazette. For each patent not more than one claim is quoted, although usually the Gazette gives several. When the number of claims in the Gazette exceeds four or five, the fact is stated in the bibliography. In quoting patent claims the phraseology and punctuation of the Gazette have been followed; but the compiler has abandoned the Gazette's use of "sulfid" for "sulphide", and other examples of "reformed" spelling, both for the sake of uniformity with the rest of the bibliography, and because he considers "sulfid" no more excusable than "filosofy".

The work on the bibliography was undertaken in March, 1917, and concluded early in November, 1918. From that date until March, 1919, the compiler was on leave of absence, in charge of the Cantonment Library at Camp A. A. Humphreys, Va., so that the final details of preparing the manuscript for the printer were attended to by Miss Irish, the Assistant Librarian. Additions have been made in the proof-sheets, so as to include material which has been published or received in this country up to June, 1919.

The compiler is indebted to Mr. Russell B. Caples, '10, Assistant Superintendent of the Zinc Plant of the Anaconda Copper Mining Co., for the two illustrations of that plant; to Dr. Charles H. Fulton, Professor of Metallurgy at the Case School of Applied Science, for the photographs showing his electric smelting furnace and its work; to Mr. Ross Bowles, Superintendent of the American Zinc Co. of Illinois, for views of the zinc works of that company; to Mr. H. F. Bradley, Chief Chemist of the Judge Mining & Smelting Co., for illustrations of the

electrolytic zinc plant at Park City, Utah; and to the St. Louis Section of the American Institute of Mining and Metallurgical Engineers for the three illustrations used on pages 200 and 346.

Mr. W. R. Ingalls, editor of the *Engineering and Mining Journal*, very kindly extended permission to use the two maps showing the smelting centers of Belgium and Silesia, which have been redrawn, with slight changes, from the *Engineering and Mining Journal*, in which they were originally published. The map showing the zinc industry of the United States is here published by courtesy of the U. S. Geological Survey, as are also the lists of smelting and electrolytic plants. The map and the lists were revised to January 1, 1919, by Mr. C. E. Siebenthal, of the Survey.

This bibliography was first suggested by Mr. Floyd D. James, of the Mining Experiment Station, in connection with certain investigations which were later published in his *Bulletin on the Hydrometallurgy and Electrolytic Precipitation of Zinc*. To him the compiler is indebted for many helpful suggestions.

Thanks are due Mr. Nelson W. McCombs of the Library School of the New York Public Library for valuable assistance in searching and verifying, at the New York Public Library and the Library of the United Engineering Societies, a large number of references to journals which are not in the Library of the Missouri School of Mines, and were not accessible to the compiler.

To Professor Horace T. Mann, of the Metallurgy Department, the compiler is especially grateful for much kindly encouragement, and for frequent and valuable assistance.

All the members of the Library staff, including those now absent, have assisted in the preparation of this bibliography. Their interest and willing spirit have helped materially to lighten the labor of its compilation.

**LIST OF JOURNALS TO WHICH REFERENCES HAVE
BEEN MADE, AND ABBREVIATIONS USED.**

Amer. Chem. Jour.

American Chemical Journal, Baltimore. In 1914 incorporated
with the Journal of the American Chemical Society.

Amer. Electrochem. Soc., Trans.

American Electrochemical Society, Transactions, Philadelphia
and South Bethlehem, Pa.

Amer. Inst. Min. Eng., Trans., and Bull.

American Institute of Mining Engineers, Transactions, and
Bulletin, New York.

Amer. Min. Cong., Rept.

American Mining Congress, Reports of annual meetings.

Ann. Chim. Anal.

Annales de Chimie Analytique et Revue de Chimie Analytique,
Paris.

Ann. de Chim. et Phys.

Annales de Chimie et de Physique, Paris. Since 1914 in two
separate series.

Annales des Mines.

Annales des Mines. Paris.

Ann. der Phys. und Chem.

Annalen der Physik und Chemie, Leipzig. Continued since
1899 as Annalen der Physik.

Atti R. Accad. Lincei.

Atti delle Reale Accademia dei Lincei, Rome.

Austral. Min. Stand.

Australian Statesman and Mining Standard, Melbourne and Sid-
ney. Since 1918 the Industrial Australian and Mining
Standard.

Berg- u Huetten. Zeitg.

Berg- und huettenmaennische Zeitung, Leipzig. In 1904 was
incorporated with Glueckauf.

Berichte der Deutsch. Chem. Gesell.

Berichte der Deutschen Chemischen Gesellschaft, Berlin.

Bull. de l'Assoc. Belge des Chim.

Bulletin de l'Association Belges des Chimistes, Gand. Since 1904 known as the Bulletin de la Societe Chimique de Belgique.

Bull. Soc. Chim. Belge.

Bulletin de la Societe Chimique de Belgique. See previous journal.

Bull. Soc. Chim. France

Bulletin de la Societe Chimique de France, Paris.

California Derrick

California Derrick, San Francisco.

Calif. Jour. Tech.

California Journal of Technology, Berkeley.

Canad. Min. Inst., Trans., and Bull.

Canadian Mining Institute, Transactions, and Bulletin, Ottawa.

Canad. Min. Jour.

Canadian Mining Journal, Toronto.

Chem. Abst.

Chemical Abstracts, Easton, Pa.

Chem. & Met. Eng.

Chemical & Metallurgical Engineering, New York. Continuation, since 1918, of Metallurgical & Chemical Engineering.

Chem. Eng. & Min. Rev.

Chemical Engineering & Mining Review, Melbourne, Australia. Formerly the Mining & Engineering Review.

Chem. Trade Jour.

Chemical Trade Journal and Chemical Engineer, London.

Chem. Zeitg.

Chemiker-Zeitung, Coethen, Germany.

Comptes Rendus

Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences, Paris.

Dingler's Polytech. Jour.

Dingler's Polytechnisches Journal, Stuttgart.

Durham Univ. Phil. Soc., Proc.

Durham University Philosophical Society, Proceedings, Newcastle-upon-Tyne, England.

- Elect. Rev.
Electrical Review, London.
- Electrical Wld.
Electrical World, N. Y.
- Electrician
Electrician, London.
- L'Electricien
L'Electricien, Paris.
- Electrochem. Ind.
Electrochemical Industry, New York. Continued since 1904 as
Electrochemical and Metallurgical Industry, and since 1909
as Metallurgical and Chemical Engineering.
- Electrochem. & Met. Ind.
Electrochemical and Metallurgical Industry, New York. A
continuation, since 1904, of Electrochemical Industry. Con-
tinued, since 1909, as Metallurgical and Chemical Engineer-
ing, and since 1918 as Chemical and Metallurgical Engi-
neering.
- Elektrochem. Zeits.
Elektrochemische Zeitschrift, Berlin.
- Engineering
Engineering, London.
- Eng. & Min. Jour., E. & M. J.
Engineering & Mining Journal, New York.
- Eng. Soc. West Pa., Proc.
Engineers' Society of Western Pennsylvania, Proceedings,
Pittsburg.
- Faraday Soc., Trans.
Faraday Society, Transactions, London.
- Glueckauf
Glueckauf, Essen, Germany.
- Inst. Min. Eng., Trans.
Institution of Mining Engineers, Transactions, Newcastle-upon-
Tyne, England.
- Inst. Min. & Met., Trans.
Institution of Mining and Metallurgy, Transactions, London.
- Iron Age
Iron Age, New York.

Iron & Coal Trades Rev.

Iron & Coal Trades Review, London.

Iron Trade Review

Iron Trade Review, Cleveland.

Jour. Amer. Chem. Soc.

Journal of the American Chemical Society, Easton, Pa.

Jour. Chem. Met. & Min. Soc. So. Africa

Journal of the Chemical, Metallurgical and Mining Society of South Africa, Johannesburg.

Jour. Chem. Soc.

Journal of the Chemical Society, London.

Jour. de Pharm. Chim.

Journal de Pharmacie et de Chimie, Paris.

Jour. Franklin Inst.

Journal of the Franklin Institute, Philadelphia.

Jour. Ind. & Eng. Chem.

Journal of Industrial and Engineering Chemistry, Easton, Pa.

Jour. Phys. Chem.

Journal of Physical Chemistry, New York.

Jour. Russ. Phys. Chem. Soc.

Journal of the Russian Physico-Chemical Society, Petrograd.

Jour. Soc. Chem. Ind., J. S. C. I.

Journal of the Society of Chemical Industry, Manchester and London.

Jour. Wash. Acad. Sci.

Journal of the Washington Academy of Sciences, Baltimore.

Met. & Chem. Eng.

Metallurgical and Chemical Engineering, New York. Continuation, since 1909, of Electrochemical and Metallurgical Industry. Continued, since 1918, as Chemical and Metallurgical Engineering.

Metall u. Erz

Metall und Erz, Halle, Germany. Continuation, since 1912, of Metallurgie.

Metallurgie

Metallurgie, Halle, Germany. Continued, since 1912, in two parts, i. e., Metall und Erz, and Ferrum.

Metal Industry

Metal Industry, London.

Metaux et Alliages

Revue Scientifique, Industrielle et Commerciale des Metaux et Alliages, Paris.

Mex. Min. Jour.

Mexican Mining Journal, Mexico City. Each issue has both English and Spanish text.

Mineral Industry.

Mineral Industry, New York. (annual)

Mines & Minerals

Mines and Minerals, Scranton, Pa. Continued, since 1913, as The Colliery Engineer.

Min. & Met. Soc. of Amer. Bull.

Mining & Metallurgical Society of America, Bulletin, New York.

Min. & Eng. Rev.

Mining & Engineering Review, Melbourne, Australia. Continued as Chemical Engineering and Mining Review.

Min. & Sci. Press

Mining and Scientific Press, San Francisco.

Min. Jour.

Mining Journal, London.

Min. Mag.

Mining Magazine, London.

Min. Mag., N. Y.

Mining Magazine, New York.

Min. Sci.

Mining Science, Denver.

Min. Wld.

Mining World, Chicago. Absorbed, 1917, in Engineering & Mining Journal, New York.

Monats. f. Chem.

Monatshefte fuer Chemie, Vienna.

Moniteur Scient.

Moniteur Scientifique, Paris.

Oester Zeits. f. Berg- u. Huetttenw.

Oesterreichische Zeitschrift fuer Berg- und Huetttenwesen, Vienna.

Revista Minera

Revista Minera, Madrid.

Rev. d'Electrochim. et d'Electromet.

Revue de l'Electrochimie et de l'Electrometallurgie, Paris.

Rev. Gen. de Chim.

Revue Generale de Chimie Pure et Appliquee, Paris.

Revue Industrielle

Revue Industrielle, Paris.

Rev. Univ. des Mines

Revue Universelle des Mines, de la Metallurgie, Paris.

Salt Lake Min. Rev.

Salt Lake Mining Review, Salt Lake City.

School of Mines Quart.

School of Mines Quarterly, Columbia University, New York.

Science

Science, New York.

Sci. Abst. A or B.

Science Abstracts A (Physics) or B (Electrical Engineering),
London.

Sci. Amer. Suppl.

Scientific American Supplement, New York.

Soe. Ingen. Civils de France, Memoires

Societe des Ingenieurs Civils de France, Memoires, Paris.

Technology Quarterly

Technology Quarterly, Boston.

Tidskrift for Kemi, Farmaci og Terapi

Tidskrift for Kemi, Farmaci og Terapi, Christiania, Norway.

West. Chem. & Met.

Western Chemist and Metallurgist, Denver.

Zeits. des Oberschles. Berg- u. Huettentm. Vereins.

Zeitschrift des Oberschlesisches Berg- und Huettentmaennisch-
es Vereins, Kattowitz, Silesia.

Zeits. f. anal. Chem.

Zeitschrift fuer analytische Chemie, Wiesbaden.

Zeits. f. angewandte Chem.

Zeitschrift fuer angewandte Chemie, Leipzig.

Zeits. f. anorgan. Chem.

Zeitschrift fuer anorganische Chemie, Leipzig.

Zeits. f. Elektrochem.

Zeitschrift fuer Elektrochemie und angewandte physikalische Chemie, Halle.

7th Int. Cong. Appl. Chem.

7th International Congress of Applied Chemistry, London, 1909. Proceedings.

8th Int. Cong. Appl. Chem.

8th International Congress of Applied Chemistry, New York and Washington, 1912. Original Communications.



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BULLETIN
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School of Mines and Metallurgy
UNIVERSITY OF MISSOURI
TECHNICAL SERIES

Vol. IV

JANUARY, 1918

No. 3

**BIBLIOGRAPHY OF THE ROASTING, LEACHING,
SMELTING AND ELECTROMETALLURGY
OF ZINC**

**SOME REFERENCES ON THE GENERAL METALLURGY
OF ZINC**

Annual reviews of progress in the metallurgy of zinc may be found in the annual volumes of "The Mineral Industry" and of the U. S. Geological Survey's publication, "Mineral Resources of the United States," both of which usually include bibliographies; also in the early January numbers, each year, of various mining periodicals, especially in The Engineering and Mining Journal.

- 1 Cours de metallurgie des metaux autre que le fer.—**Eugene Prost.** Paris and Liege, Beranger, 1912. 888pp., diagr., 8°.

Metallurgy of the non-ferrous metals. The first 148 pages are devoted to the metallurgy of zinc, chiefly roasting and smelting.

- 2 Handbook of metallurgy.—**Carl Schnabel;** translated by Henry Louis. 2nd edition. London, Macmillan & Co., 1905-1907. 2 vols. illus., diagr., 8°.

The metallurgy of zinc is discussed in vol. 2, pp. 1-316. Contents: Zinc ores; Preparation of ores for reduction; Process of reduction; Belgian and Silesian methods; Older, direct-fired furnaces; Experiments and proposals for the improvement of the dry method; Extraction by combined wet and dry methods; Electrolytic extraction; Electrolytic extraction in the dry way.

1st German edition, 2 vols., Berlin, 1894-96; 1st English edition, 2 vols., London, 1898; 2nd German edition, 2 vols., Berlin, 1901-04; 2nd English, from the 2nd German edition, 2 vols., London, 1905-07; 3rd German edition, 2 vols., announced, 1915, as forthcoming shortly.

- 3 **Metallurgie du zinc.—A. Lodin.** Paris, Dunod, 1905. 810 pp., illus., diagr., 8°.

Calcination of calamines; Roasting of blendes; Reduction of zinc ores, with detailed description of various methods and types of furnaces; Electrolytic zinc; Zinc white.
- 4 **The metallurgy of zinc and cadmium.—Walter Renton Ingalls.** 2nd edition. N. Y., McGraw-Hill Book Co., 1906. 701pp., illus., diagr., 8°.

Zinc and its ores; Calcination of calamine; Blende roasting; Roasting furnaces; Utilization of the sulphurous gases; General principles of zinc distillation; Retort and condenser manufacture; Fuel and systems of combustion; Chimneys, heat recuperation and furnace design; Distillation furnaces; Practice in distillation; Losses in distillation; Refining impure zinc; Cadmium and its recovery; Cost of producing zinc; Design and construction of smelting works; Examples from practice; Proposals to smelt zinc ore in the blast furnace; Manufacture of zinc dust, zinc white, zinc sulphate and zinc chloride.
- 4a **The zinc industry.—Ernest A. Smith,** London, Longmans, Green & Co., 1918. 223 pp., illus., 8°. (Monographs on Industrial Chemistry.)

History of zinc; Rise and progress of the production of zinc; Zinc ores and their sources of supply; Marketing zinc ores; Zinc smelting; Other methods of zinc production; Physical and chemical properties of zinc; Industrial zinc alloys. Bibliography, pp. 213-221.
- 5 **Zink und Cadmium, und ihre Gewinnung aus Erzen und Nebenprodukten.—R. G. Max Liebig.** Leipzig, Otto Spamer, 1913. 598pp., illus., diagr., 8°.

Historical review; The Silesian, Belgian and Rhenish methods; Calcination of calamine; Roasting of blende; Reduction, distillation and condensation of zinc; Electric smelting; Electrolytic zinc.
- 6 **The action on zinc of dilute sulphuric acid.—F. Pullinger,** Jour. Chem. Soc., vol. 57, pp. 815-27. 1890.

The effect on zinc with smooth or rough surface, or sulphuric acid which has been boiled; influence of reducing agents.

—Abstract. Jour. Soc. Chem. Ind., vol. 9, pp. 946-47. Oct. 31, 1890.
- 7 **The behaviour of certain alloys when heated in vacuo.—Thomas Turner.** Jour. Inst. Metals, vol. 7, pp. 105-22. 1912.

"Zinc and other metals are entirely removed from copper-zinc alloys when the latter are heated in a vacuum."

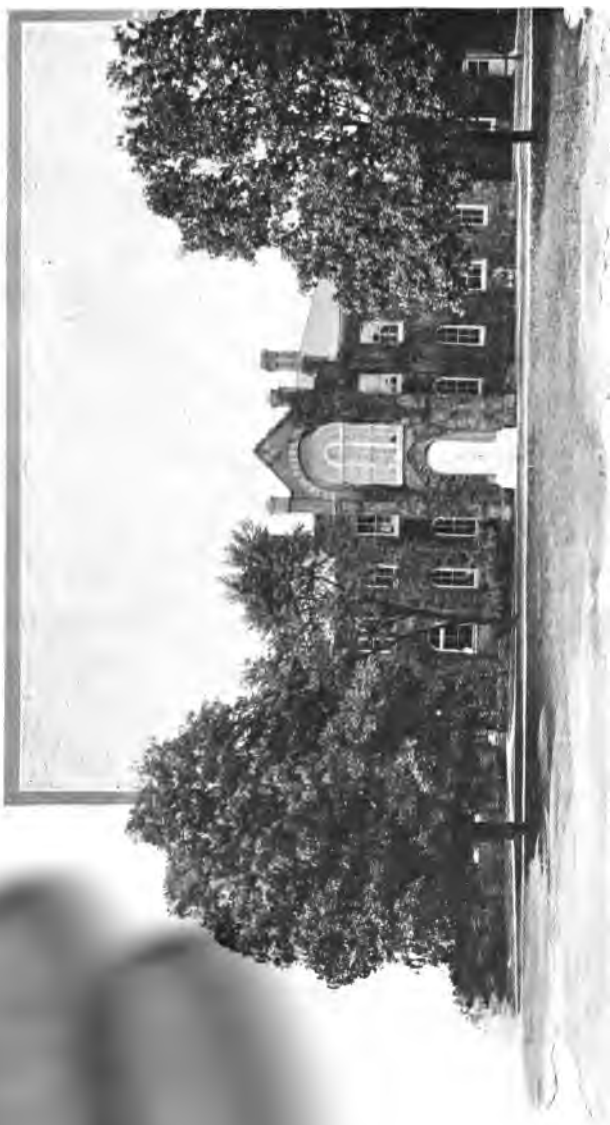
—Abstract. Jour. Soc. Chem. Ind., vol. 31, p. 134. Feb. 15, 1912.

- 8 Comments and speculations on the metallurgy of zinc.—**W. R. Ingalls.** *diagr. Eng. & Min. Jour.*, vol. 102, pp. 621-24. Oct. 7, 1916.
 "A discussion of the details of zinc metallurgy and some of the improvements that may be realized." Electrolytic zinc; zinc burning; fume collecting; roasting and distillation furnaces; briquetting; retorts; pre-reduction.
 —Abstract. *Jour. Soc. Chem. Ind.*, vol. 35, p. 1159. Nov. 30, 1916.
- 9 Decomposition of zinc carbonate by alkali chlorides in the presence of water.—**A. Cantoni and J. Passamanik.** *Ann. Chim. Anal.*, vol. 10, pp. 258-62. 1905. In French.
 —Abstract. *Jour. Soc. Chem. Ind.*, vol. 24, p. 925. Sept. 15, 1905.
- 10 The development of the spelter industry.—**Ernest A. Smith.** *Jour. Inst. Metals*, vol. 16, pp. 118-95. 1916.
 American and European practice; treatment of complex ores; smelting, electric smelting and hydrometallurgical extraction; future of the zinc industry. Discussion by H. K. Picard, Robert Mond, W. Rosenhain, H. M. Ridge, and others.
 —Abstract. *Min. Jour.*, vol. 114, pp. 647, 665-66, 680-83, 689-90, 699-700. Sept. 23, 30, Oct. 7, 14, 21, 1916.
 —Abstract. *Jour. Soc. Chem. Ind.*, vol. 35, pp. 996-99. Oct 16, 1916.
- 11 Fortschritte in der Metallurgie von Zink, Kupfer, Blei, Gold und Silber im Jahre 1913.—**K. Nugel.** *illus. Metall u. Erz*, vol. 11, pp. 226-42. Apr. 8, 1914.
 Progress in 1913. Muffle process, treatment of residues, electrothermic methods.
 —Abstract. *Min. Wld.*, vol. 42, p. 459. Mar. 6, 1915.
- 12 Losses in zinc metallurgy. *Eng. & Min. Jour.*, vol. 104, pp. 949-50. Dec. 1, 1917.
- 13 Losses of zinc in mining, milling and smelting.—**Dorsey A. Lyon and S. S. Arentz.** *Amer. Inst. Min. Eng., Trans.*, vol. 49, pp. 789-801. 1914.
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CHEMISTRY BUILDING



ANALYSIS, DETERMINATION, ESTIMATION

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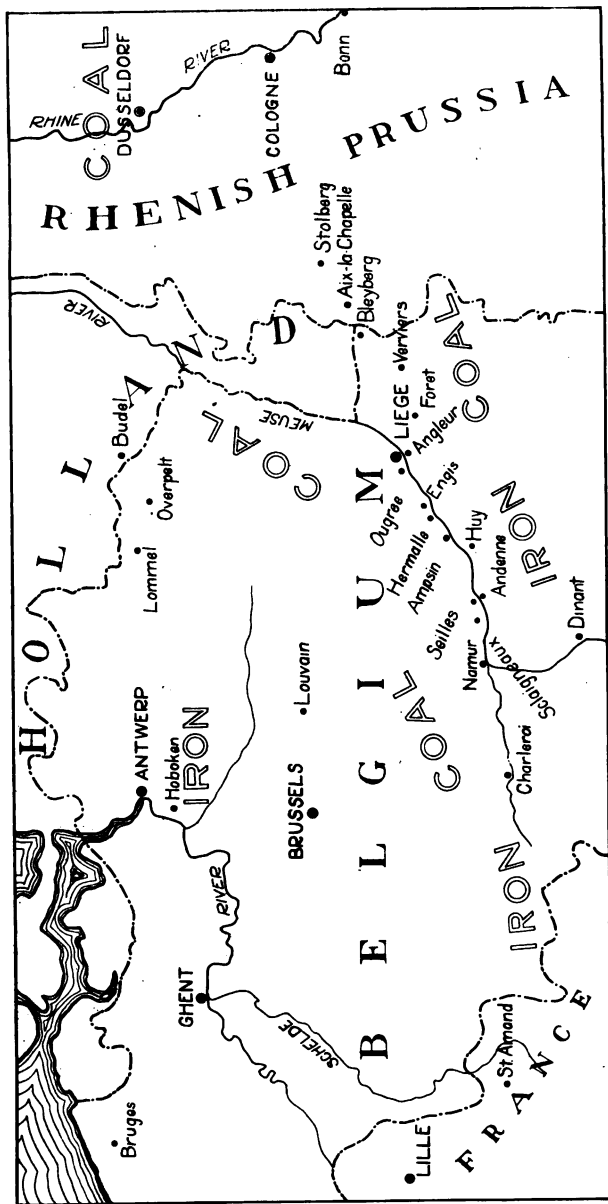
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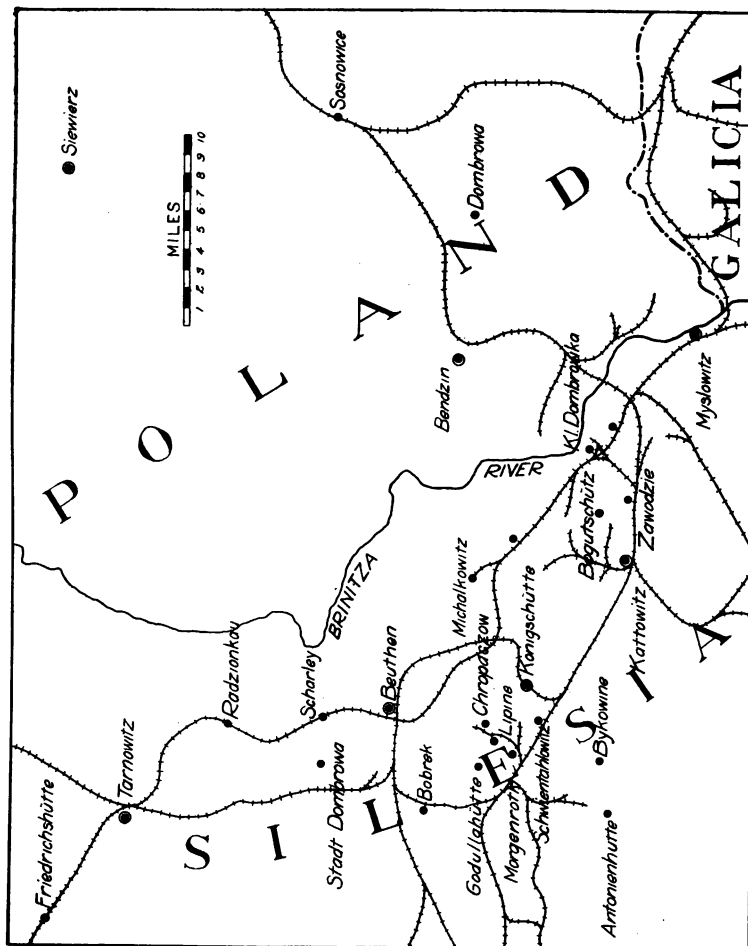
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THE LEAD AND ZINC SMELTING CENTERS OF BELGIUM



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PORTIONS OF POLAND, GALICIA AND SILESIA

ROASTING

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Chloridizing roasting

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- 265 Roasting and leaching tailings at Anaconda.—**Frederick Laist.** *diagr. Min. & Eng. Wld.*, vol. 39, pp. 545-48, 599-601. Sept. 27, Oct. 4, 1913.
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Angell's Patent 837,273. "The object is to produce soluble sulphates direct from zinciferous ores which are sulphide blende."
- 267 The roasting of blendes.—**M. V. M. de Lummen.** *Chem. Trade Jour.*, vol. 59, pp. 261-62. 1916.
"A study of three systems applicable to the roasting of Australian concentrates, i. e., the Hegeler, Spirlet, and Delplace. Data of operation and comparative costs are given," based on prices ruling before the war. See also item 202.
—Same. *Eng. & Min. Jour.*, vol. 102, pp. 741-42. Oct. 21, 1916.
—Abstract. *Jour. Soc. Chem. Ind.*, vol. 35, p. 1064. Oct. 31, 1916.
—Abstract. *Chem. Abst.*, vol. 10, p. 3053. Dec. 10, 1916.
- 268 Roasting of sphalerite.—**Joseph W. Richards.** *Electrochem. & Met. Ind.*, vol. 6, pp. 141-43. April, 1908.
Published later in his book "Metallurgical calculations," pt. 3. N. Y., McGraw-Hill Book Co., 1908.
- 269 Roasting of zinc ore for retort smelting. *Met. & Chem. Eng.*, vol. 15, p. 158. Aug. 1, 1916.
De Saulles' U. S. Patent 1,183,172. Adds carbon in the form of anthracite coal to the roasting ore, with the effect that undesirable constituents are broken up at the higher temperature produced."
- 270 Roasting zinc flotation concentrates. *Met. & Chem. Eng.*, vol. 14, p. 103. Jan., 1916.
L. C. Drefahl's Patent 1,153,203. Mixes the fine concentrates with moisture to make a plastic mass.

- 271 Roasting zinc blende.—**W. Minor.** Chem. Zeitg., vol 13, pp. 1602-3. 1889.
 The time required for the elimination of sulphur from different varieties of blende varies from two to six hours. To determine the cause of this variation, the author carefully selected samples and analyzed them at intervals. In German.
 —Abstract. Jour. Soc. Chem. Ind., vol. 9, p. 76. Jan. 31, 1890.
- 272 Roestoeften fuer Blende und Pyrite.—**W. R. Ingalls.** diagr. Metallurgie, vol. 1, p. 449-56. Nov. 8, 1904.
 American roasting practice, with descriptions of McDougall, Herreshoff, Klepetko and other furnaces.
 —Abstract. Zeits. f. angewandte Chem., vol. 18, p. 343. Mar. 3, 1905.
- 273 Some practical notes on ore roasting.—**J. E. Edwards.** Min. Wld., vol. 32, pp. 553-55. Mar. 12, 1910.
- 274 Studien ueber Abroestung von Zinksulfidniederschlaegen und ueber ein neues Mittel zur schnellen Ausflockung dieser Niederschlaege aus saurer Loesung. (Gegenseitige Faellung zweier Kolloide, angewandte auf ein analytisches Problem.)—**K. Bornemann.** Zeits. f. anorg. Chem., vol. 82, pp. 216-39. July 8, 1913.
 The roasting of zinc sulphide precipitates and a method for their rapid separation in an acid solution. Precipitates of zinc sulphide may be accurately roasted direct to oxide.
 —Abstract: Zinc sulphide precipitates. Jour. Inst. Metals, vol. 10, pp. 438-39. 1913.
- 275 Sulphur in roasting.—**William E. Greenawalt.** Eng. & Min. Jour., vol. 80, pp. 1164-65. Dec. 23, 1905.
 —Correction. vol. 81, p. 238. Feb. 3, 1906.
- 276 Ueber die Bleiverfluechtigungen beim Roesten bleihaltiger Zinkblendes.—**Karl Sander.** Berg- u. Huettentm. Zeitg., vol. 61, pp. 561-62. Nov. 7, 1902.
- 277 Ueber sulfatisierende Roestung der sulfidischen Erze.—**Rudolf Vondracek.** Oester. Zeits. f. Berg- u. Huettentw., vol. 54, pp. 437-41, and vol. 55, pp. 95-96. 1906-07.
- 278 The utilization of the sulphur contents of zinc ore.—**H. M. Ridge.** diagr. Jour. Soc. Chem. Ind., vol. 36, pp. 676-85. July 16, 1917.
 Discusses the extraction of the sulphur and its utilization; describes the Hasenclever, Rhenania, Delplace, Hegeler, Merton, Spirlet and Ridge furnaces.
 —Same. diagr. Met. & Chem. Eng., vol. 17, pp. 215-24. Sept. 1, 1917.

- Same. diagr. Austral. Min. Stand., vol. 58, pp. 260-62. Oct. 25, 1917.
- Abstract. Min. Mag., vol. 17, pp. 41-42. July, 1917.
- Abstract. Chem. Abst., vol. 11, p. 3096. Nov 20, 1917.
- 279 Verarbeitung gemischter sulfidischer Zinkerze mit Ferri-sulfat unter Oxydation des entstehenden Ferrosulfats und unter Nutzbarmachung der beim Kalzinieren von Zink-sul erzeugten sauren Gase fuer den Arbeitsgang. Metallurgie, vol. 5, pp. 588-89. Oct. 8, 1908.
- Working up mixed sulphide zinc ores with ferric sulphate, oxidizing the resulting ferrous sulphates, and utilizing the acid gases by calcination of the zinc sulphate. De Bechi and Ruecker's German Patent 200,613.
- 280 Verfahren und Vorrichtung zum Roesten von Zinkblende, bei denen das Roestgut in eine drehbare Roestkammer eingefuehrt wird, in der eine oxydierende Roestatmosphaere aufrecht erhalten wird, wahren sich die Charge in Bewegung befindet. diagr. Metall u. Erz., vol. 12, pp. 510-11. Dec. 22, 1915.
- Process and apparatus for roasting zinc blende, the roast being placed in a rotating chamber in which an oxidizing atmosphere is maintained, and the charge is kept in motion. German Patent 288,648, by A. L. J. Queneau. See item 397.
- 281 The zinc industry in Silesia in 1905.—**Paul Speier.** Eng. & Min. Jour., vol. 81, p. 176. Jan. 27, 1906.

Roasting for magnetic separation

- 282 Electric furnace conversion of iron pyrites into a magnetic form.—**O. L. Kowalke.** diagr. Amer. Electrochem. Soc., Trans., vol. 13, pp. 133-42. 1908.
- In preparing mixed sulphide zinc ores for smelting, the removal of iron pyrites is often accomplished by roasting, so as to convert the iron magnetic sulphide to a metallic form. This investigation was to determine the temperature and conditions under which iron pyrites can be made magnetic.
- Abstract in German. Metallurgie, vol. 5, pp. 539-40. Sept. 22, 1908.
- 283 The new Wilfley roaster. Eng. & Min. Jour., vol. 91, p. 622. Mar. 25, 1911.
- 284 The removal of iron from zinc blende.—**William B. Phillips.** Eng. & Min. Jour., vol. 72, pp. 710-11. Nov. 30, 1901.
- Correspondence.—**Gilbert Rigg.** vol. 72, p. 857. Dec. 28, 1901.
- Abstract. Jour. Soc. Chem. Ind., vol. 21, pp. 120-21. Jan. 31, 1902.



**HEGELER ROASTING FURNACE,
AMERICAN ZINC, LEAD & SMELTING CO.**



HEGELER ROASTING FURNACE, END VIEW
AMERICAN ZINC, LEAD AND SMELTING CO.

- 285 Roasting and magnetic separation of a blende marcasite concentrate.—**H. O. Hofman** and **H. L. Norton**. illus. Amer. Inst. Min. Eng., Trans., vol. 35, pp. 928-47. 1905.
 Marcasite and blende "can be successfully separated by crushing through a 20-mesh screen, roasting from 5 to 10 minutes at a temperature not exceeding 400° C., and then subjecting to two double-pole magnets."
 —Same. Technology Quarterly, vol. 18, pp. 86-104. Mar. 1905.
 —Abstract. Zeits. f. angewandte Chem., vol. 19, pp. 36-37. Jan. 5, 1905.
- 286 Roasting for magnetic separation of zinc ores.—**Frank H. Trego**. diagr. Eng. & Min. Jour., vol. 83, pp. 613-16. Mar. 30, 1907.
 "A comparison of the work of the cylindrical furnace commonly used in southwestern Wisconsin with that of a new circular table roaster."—E. & M. J.
 —Correspondence.—**C. C. Mathey**. Eng. & Min. Jour., vol. 83, p. 1060. June 1, 1907.
 —Reply.—**F. A. Trego**. p. 1205. June 22, 1907.
- 287 Wilfley roasting process.—**J. M. McCave**. diagr. Mines & Minerals, vol. 28, p. 407. April, 1908.
- 288 The Wilfley rotary-hearth roaster. Eng. & Min. Jour., vol. 99, pp. 414-15. Feb. 27, 1915.

PATENTS ON ROASTING

United States

- 289 495,593. Process of manufacturing zinc oxide.—**George T. Lewis**, Philadelphia, Pa. Filed Sept. 28, 1891. Issued April 18, 1893.
 The process of manufacturing zinc oxide from zinc ores containing sulphur, which consists in mixing with the ore sodium nitrate or its equivalent in quantity sufficient to unite with the sulphur present, roasting the mixture to effect the formation of a soluble sulphate, leaching out the soluble sulphate and finally oxidizing the zinc in the ores thus freed from sulphur and collecting the zinc oxide fume.
- 290 523,650. Roasting furnace.—**John Roger**, Denver, Colo. Filed May 29, 1893. Issued June 24, 1894.
- 291 566,750. Roasting furnace.—**John B. F. Herreshoff**, Brooklyn, assignor to the Nichols Chemical Company, New York. Filed March 29, 1895. Issued March 24, 1896.
- 292 569,901. Roasting furnace.—**James L. Wells**, Leadville, Colo. Filed Nov. 29, 1895. Issued October 20, 1896.

- 293 579,536. Roasting furnace.—**Jared E. Gaylord, William G. Cole, and Hermann A. Keller**, Butte, Mont. Filed March 10, 1894. Issued March 23, 1897. 23 claims.
- 294 579,711. Roasting furnace.—**Hermann A. Keller, William G. Cole, and Jared E. Gaylord**, Butte, Mont. Filed April 9, 1894. Issued March 30, 1897. 17 claims.
- 295 616,926. Roasting furnace.—**John B. F. Herreshoff**, New York. Filed Dec. 28, 1897. Issued January 3, 1899.
- 296 623,833. Roasting and smelting furnace.—**James A. Russell**, Tacoma, Wash. Filed July 30, 1898. Issued April 25, 1899.
- 297 624,048. Roasting furnace.—**Hermann A. Keller**, Butte, Mont. Filed Feb. 19, 1896. Issued May 2, 1899.
- 298 629,023. Roasting furnace.—**Lewis T. Wright**, Keswick, Cal. Filed November 24, 1897. Issued July 18, 1899.
- 299 641,460. Furnace for roasting and reducing ores.—**Harison B. Meech**, Denver, Col. Filed Mar. 4, 1899. Issued Jan. 16, 1900.

In a cylindrical roasting-furnace, two or more ovens one above the other, each having an opening in the bottom or bed thereof, and a rotary, flanged, discharge-wheel located in each of said openings; in combination with a hollow vertical shaft in sections, joined together by center pieces having horizontal arms fast thereto, said center pieces and arms each interiorly divided into two chambers by a horizontal partition therein, and mechanism for rotating said shaft, in combination with a pawl-and-ratchet mechanism connected to said discharge-wheel and actuated by said arms.

- 300 642,334. Ore roasting and desulphurizing furnace.—**Albert C. Johnson**, Baltimore, Md. Filed Apr. 29, 1898. Issued Jan. 30, 1900.

In an ore roasting or desulphurizing furnace, longitudinal side beams having intersecting longitudinally-extending lateral and vertical slots, in combination with a reciprocating rake, the latter comprising a head with right-angled ends, and with teeth which are triangular in cross-section and arranged in staggered form, said rake pivoted to the head, endless chains or cables connected with the angular ends of the rake-head, and supported in the slot or pocket and on idlers exterior to the heating-chambers, and means for reciprocating the chain or cable. 5 claims.

- 301 645,761. Apparatus for oxidizing or roasting refractory ores.—**Robert A. Stewart**, Kansas City, Mo. Filed Dec. 15, 1899. Issued March 20, 1900.

An apparatus comprising a rotary ore-retaining cylinder, having a neck-passage, and an exit-opening of smaller diameter than said neck-passage, a furnace communicating with said neck-passage, a

steam-pipe for discharging steam through the furnace and said neck-passage into said cylinder, and means for discharging steam and air into said neck-passage at an angle to the first named steam-pipe.

- 302 648,183 Roasting furnace.—**Utley Wedge**, Bayonne, N. J. Filed Sept. 29, 1898. Issued April 24, 1900.

In a roasting-furnace the combination with the roasting-chamber of a central shaft extending vertically through the roasting-chamber and having in said chamber arms provided with stirring-blades, a rim secured to said shaft beneath said chamber, wheels or rollers supporting said rim, and means for continuously rotating said shaft. 16 claims.

- 303 653,202. Ore roasting furnace.—**Philip Argall**, Denver. Filed Sept. 28, 1899. Issued July 10, 1900. 13 claims.

An ore roasting furnace provided with a reciprocating bottom, longer than the said furnace, and means for moving said bottom back and forth a specific distance equal to said excess of length, whereby the furnace always remains closed at the bottom.

- 304 654,335. Roasting furnace.—**Utley Wedge**, Ardmore, Pa. Filed Mar. 13, 1899. Issued July 24, 1900.

The combination of a tier of roasting chambers, furnace chambers interposed in the series of roasting chambers and not communicating therewith, but so communicating with each other that the combustion products of one furnace chamber are conducted into another, passages connecting the roasting chambers, with each other, whereby the material in the roasting chambers may be passed from chamber to chamber out of contact with any gases other than those generated therein, and stirring mechanism in each roasting chamber.

- 305 676,417 and 676,418. Apparatus for and method of roasting ores.—**Henry Carmichael**, Malden, Mass., assignor to the Carmichael Reduction Company, Portland, Me. Filed Jan. 24, 1901. Issued June 18, 1901.

The method of roasting refractory oxidizable ores, which consists in passing the ore forward through a combustion zone, oxidizing the combustible ingredients of said ore as completely as possible within said zone by the action of air, substantially wholly by the oxidation of the ore therein, and substantially retaining the heat produced by said oxidation; then passing the nearly oxidized ore through a second zone and simultaneously subjecting it in a disseminated condition to extraneous heat and to the action of air uncontaminated by products of combustion, whereby further oxidation of the ore is effected and practically all of the sulphur and arsenic are removed, and a dead roast obtained; positively disseminating the ore on its passage through said second zone, and supplying the requisite air by moving a current of air in contact with the ore and through the disseminated portion thereof but in the opposite direction to the line of feed of the ore.

- 306 677,263. Process of roasting mixed sulphide ores.—**Ernest C. H. Pape** and **Carl A. L. W. Witter**, Hamburg, Germany. Filed July 18, 1899. Issued, June 25, 1901.

The process of treating sulphide ores containing metals which are volatile at a temperature at which they cannot combine with oxygen, which consists in heating in a combustion chamber to a temperature necessary to ignite the sulphides in the ore, introducing a heated current of air in the said chamber, then feeding the finely divided ore into the chamber so that it passes through the current of heated air, maintaining the temperature above that at which a part of the metals can combine with oxygen, allowing the metallic vapors carried forward to combine with oxygen, and then collecting the matters so carried forward.

307 677,510. Roasting-Furnace.—**Benjamin Hall**, Nevada City, Cal. Filed Jan. 18, 1901. Issued July 2, 1901. 9 claims.

308 677,701. Ore-roasting Furnace.—**John Roger**, Denver, Col. Filed Feb. 12, 1901. Issued July 2, 1901. 3 claims.

309 678,078. Apparatus for desulphurizing ores or other substances.—**John P. Wetherill**, South Bethlehem, Pa. Filed November 6, 1897. Issued July 9, 1901.

The method of roasting by furnace heat a progressively moving or advancing charge of ore containing sulphur, which consists in excluding therefrom the products of combustion of the heating-furnace, admitting air at an initial portion of the ore and partially oxidizing the sulphur thereby, maintaining the roasting temperature along an advanced portion of the charge by the combustion of the sulphur, withdrawing the sulphur fumes at said advanced portion so as to prevent them from passing on over the remainder of the ore, and finally admitting additional quantities of air to oxidize the sulphur in portions of the charge still further advanced. 11 claims.

310 685,903. Roasting-furnace.—**John A. Bentley**, Denver, Col. Filed Feb. 19, 1900. Issued Nov. 5, 1901. 6 claims.

311 691,112. Ore roasting furnace.—**Joseph P. Cappeau**, Joplin, Mo. Filed Apr. 20, 1901. Issued Jan. 14, 1902.

312 692,008. Separating process for ores.—**Oscar Frol'ch**, Charlottenburg, **Max Huth**, Halensee, and **Arthur Edelmann**, Charlottenburg, Germany, assignors to Siemens & Halske Aktiengesellschaft, Berlin, Germany. Issued Jan. 28, 1902.

The process consists in heating the ore to a temperature below the decomposition temperature of the sulphate of the metals to be sulphated, but above the decomposing temperature of the sulphate of any other metal existing in the ore and then passing it over a gas mixture containing sulphur dioxide and oxygen.

313 691,148. Process of treating ores.—**Elizabeth B. Parnell**, Carshalton, England. Issued Feb. 11, 1892.

In the treatment of refractory ores, a process which consists in subjecting them to the action of chromic acid and then roasting them.

- 314 700,339. Roasting furnace.—**Frank Klepetko and William J. Evans**, Great Falls, Mont. Issued May 20, 1902.

In a furnace of the class described, a hearth, a roof therefor, a hopper thereabove having a constricted opening, means for agitating the material to be treated in the opening of said hopper consisting of rotary stirring arms projected from the upper outer edge of said hopper to the discharge opening thereof, and separate means for feeding the material from said hopper to said hearth.

- 315 705,904. Desulphurizing of sulphide ores preparatory to smelting.—**Archibald D. Carmichael**, Broken Hill, New South Wales, Australia. Issued July 29, 1902.

A process of treating mixed sulphide ores, which consists in mixing with said ores a sulphur compound of a metal of the alkaline earths, starting the reaction by heating the same, thereby oxidizing the sulphide and reducing the sulphur compound of the alkali metal, passing a current of air to oxidize the reduced sulphur compounds of the metal of the alkalies preparatory to acting upon a new charge of sulphide ores.

- 316 709,482. Process of eliminating the sulphur from sulphide ores.—**Adolph Gutensohn**, London, England, assignor to Sulphur Elimination Syndicate, Ltd., London. Issued Sept. 23, 1902.

A process for the elimination of sulphur from sulphide ores, consisting in crushing the ore, mixing it with carbon and a sodium salt which will yield sulphide of sodium when the mixture is heated, the amount of carbon being added largely in excess of the amount required to form the sulphide of sodium, heating the mixture to a temperature approaching incipient redness and then exposing it freely to air to effect its oxidation and burn off all the sulphur that is set free.

- 317 736,929. Roasting furnace.—**Edward C. Brice**, Colwyn, Pa. Filed October 7, 1902. Issued August 23, 1903.

- 318 737,060. Art of treating ores for recovery of zinc and copper.—**Aron M. M. Beam**, Denver, Colorado. Filed May 12, 1899. Issued August 23, 1903.

The process of recovering zinc or copper from ores, consisting in first pulverizing the ore, then subjecting it, in connection with a suitable oxidizing flux or reagent mixed therewith, in a closed oven or muffle, to the action of a low degree of indirect heat while the air is excluded, for a short time, or until the sulphides of zinc or copper are partially converted into sulphates, so that the air may be afterward admitted without burning the sulphur, then admitting air to the ore in the oven or muffle, and completing the conversion of the sulphides into sulphates by subjecting the ore for a further short time to a low degree of indirect heat, then leaching the converted ore with water and finally precipitating.

- 319 756,485. Roasting or desulphurizing furnace.—**Frederick J. Falding**, New York, N. Y. Filed June 14, 1901. Issued April 5, 1904. 8 claims.

- 320 760,941. Ore-treating furnace.—**Christopher C. Wilson**, Denver, Colorado. Filed Aug. 18, 1903. Issued May 24, 1904.
- 321 761,049. Ore-roasting furnace.—**William H. Smyth**, Berkeley, Cal. Filed March 12, 1901. Issued May 24, 1904. 40 claims.
- 321a 761,050. Ore-roasting furnace.—**William H. Smyth**, Berkeley, Cal. Filed March 12, 1901. Issued May 24, 1904. 10 claims.
- 322 768,748. Roasting furnace.—**Ottokar Hofmann**, Argentine, Kansas. Assignor to the United Zinc and Chemical Company, Kansas City, Mo. Filed August 29, 1903. Issued August 30, 1904. 8 claims.
- 323 775,147. Ore-roasting furnace.—**Andrew P. O'Brien**, Richmond, Va. Filed April 3, 1903. Issued September 15, 1904. 26 claims.
- 324 779,310. Process of obtaining metals from their ores—**Samuel Peacock**, Chicago, Ill. Filed Feb. 17, 1904. Issued January 3, 1905.
- The process of treating ores containing iron and zinc which consists in roasting the same, reducing the iron to a metallic state at a temperature too low to reduce the zinc to a metallic state, separating the iron from the mass and then reducing the zinc to a metallic state.
- 325 779,717. Roasting furnace.—**Frank Klepetko**, New York, N. Y. Filed Oct. 3, 1904. Issued January 10, 1905.
- In a furnace having a plurality of hearths, a rotatable hollow shaft passing through the hearths, a series of hollow arms radiating from said shaft and extending into the several hearths, a series of chambers distributed throughout the shaft and communicating with the hollow arms, means for permitting the circulation therethrough of a current of air, and a series of deflecting-ribs disposed along the inner surfaces of the hollow arms. 10 claims.
- 326 780,115. Roasting furnace.—**August R. Meyer**, Kansas City, Mo., assignor to the United Zinc and Chemical Company, Kansas City, Mo. Filed March 17, 1904. Issued January 17, 1905. 19 claims.
- 327 781,824. Rotary ore roasting furnace.—**Ferdinand Heberlein**, London, and **Woldemar Hommel**, Lee, England. Filed June 11, 1904. Issued Feb. 7, 1905.

A rotary muffle-furnace for roasting ores or the like, comprising an ore-chamber the floor of which rotates, a heating chamber immediately beneath, rotating with the floor of the ore-chamber, and a stationary heating-chamber immediately above the ore-chamber; the heating gases being caused to circulate first through the lower heating chamber and subsequently through the upper one.

- 328 785,437. Roasting furnace.—**Charles Repath** and **Frank E. Marcy**, New York, N. Y., assignors to Frank Klepetko, New York, N. Y. Filed May 9, 1904. Issued March 21, 1905.

In a furnace having a plurality of superposed hearths, means for conducting the material from one hearth to the next hearth below in such a manner that there is always an uninterrupted body of material connecting the material on one hearth with that on the next adjacent hearth.

- 329 786,567. Roasting furnace.—**Walter R. Ingalls**, Lynn, Mass. Filed Feb. 15, 1904. Issued April 4, 1905.

- 330 786,599. Roasting furnace.—**Charles H. Repath** and **Frank E. Marcy**, New York, N. Y., assignors to Frank Klepetko, New York, N. Y. Filed May 25, 1904. Issued April 4, 1905.

- 331 792,053. Roasting furnace.—**Frank Klepetko**, New York. Filed Dec. 31, 1904. Issued June 13, 1905. 9 claims.

- 332 793,939. Roasting furnace.—**Frank E. Klepetko**, New York, N. Y. Filed Oct. 22, 1904. Issued July 4, 1905.

- 333 794,198. Process of removing or recovering zinc from ores. **William Stewart**, Mount Florida, Glasgow, Scotland. Filed June 28, 1904. Issued July 11, 1905.

A process for removing or recovering zinc from ores containing it, said process consisting of pulverizing the ores, mixing therewith bisulphate of an alkali metal, and common salt, furnacing at a red heat and thereafter lixiviating or leaching and precipitating the zinc salts.

- 334 794,837. Roasting furnace.—**Joseph A. Anker**, **James H. Watson**, and **Pierce Evans**, Los Angeles, Cal.; said Anker and Evans assignors to said Watson. Filed Dec. 10, 1903. Issued July 18, 1905. 9 claims.

- 335 799,063. Roasting furnace.—**Frank Klepetko**, New York, N. Y. Filed Mar. 15, 1905. Issued Sep. 12, 1905. 8 claims.

- 336 799,743 Process of treating zinc ores.—**Philip A. Mackay**, Wenona, Ill. Filed June 9, 1902. Issued Sept. 19 1905.

The process of treating zinc ores containing cadmium sulphide and zinc sulphide, which consists in subjecting ore to a dead roast, whereby the zinc sulphide is oxidized and the cadmium sulphide converted into cadmium sulphate, thereafter dissolving out this deleterious sulphate and then grinding and distilling the remaining zinc oxide to obtain therefrom the pure refined zinc.

- 337 799,745. Metallurgical furnace.—**Philip A. Mackay**, Newcastle, New South Wales, Australia. Filed Apr. 29, 1903. Issued Sept. 19, 1905.

- 338 800,588. Roasting furnace.—**August R. Meyer**, Kansas City, Mo., assignor to the United Zinc and Chemical Co., Kansas City, Mo. Filed Oct. 12, 1903. Issued Sept. 26, 1905.
- 339 804,751. Roasting furnace.—**August R. Meyer**, Kansas City, Mo., assignor to the United Zinc and Chemical Co., Kansas City, Mo. Filed Mar. 17, 1904. Issued Nov. 14, 1905.
- 340 804,752. Roasting furnace.—**August R. Meyer**, Kansas City, Mo., assignor to the United Zinc and Chemical Co., Kansas City, Mo. Filed Mar. 17, 1904. Issued Nov. 14, 1905.
- 341 809,953. Roasting furnace.—**Ottokar Hofmann**, Argentine, Kans., assignor to the United Zinc and Chemical Co., Kansas City, Mo., a Corporation of New Jersey. Filed Feb. 19, 1904. Issued Jan. 16, 1906. 8 claims.
- 342 811,643 Roasting furnace.—**Frank Klepetko**, New York, N. Y. Filed Nov. 6, 1905. Issued Feb. 6, 1906. 12 claims.
- 343 814,297. Roasting furnace.—**Frank Klepetko**, New York, N. Y. Filed Nov. 6, 1905. Issued Mar. 6, 1906. 8 claims.
- 344 814,298. Roasting furnace.—**Frank Klepetko**, New York, N. Y. Filed Nov. 6, 1905. Issued Mar. 6, 1906. 18 claims.
- 345 814,299. Roasting furnace.—**Frank Klepetko**, New York, N. Y. Filed Nov. 6, 1905. Issued March 6, 1906. 7 claims.
- 346 815,516. Apparatus for converting zinc sulphate solution into zinc oxide.—**Chauncey E. Dewey**, Denver, Colo. Filed Jan. 24, 1905. Issued Mar. 20, 1906.
- In an apparatus for converting zinc sulphate into zinc oxide, the combination of two independently-revoluble axially-aligned chambers arranged in suitable proximity to each other and having adjacent open extremities, means for delivering heat to one chamber at its extremity remote from the other chamber, means for delivering the zinc-sulphate solution to the chamber remote from the heat generating means, and means exterior to the chambers for transferring the contents of the last-named chamber to its companion chamber. 5 claims.
- 347 824,181. Roasting furnace.—**Frank Klepetko**. New York. Filed Nov. 17, 1905. Issued June 26, 1906. 14 claims.
- 348 825,446. Tilting ore roasting furnace.—**Thomas Edwards**, Ballarat, Victoria, Australia. Filed Aug. 7, 1905. Issued July 10, 1906.
- 349 827,226. Roasting furnace.—**Herbert W. Fox**. Colorado Springs, Colo. Filed Feb. 21, 1906. Issued July 31, 1906.

350 831,166. Roasting furnace.—**Frank Klepetko**, New York, N. Y. Filed Nov. 6, 1905. Issued Sept. 18, 1906.

351 832,248. Ore roasting furnace.—**Thomas Edwards**, Ballarat, Victoria, Australia. Filed Dec. 19, 1903. Issued Oct. 2, 1906.

A water cooled stirring shaft provided with a partition dividing the shaft into two compartments, said partition forming the end of one compartment, a stirrer-arm and means connected to the stirrer-arm for providing circulation through the arm and shaft.

352 837,273. Furnace for sulphating zinc-bearing ores.—**George O. Angell**, Philadelphia, Pa. Filed Dec. 30, 1904. Issued Dec. 4, 1906.

A furnace for roasting and sulphating zinciferous ores, comprising a chamber adapted to operate primarily as a roasting chamber and secondarily as a sulphating-chamber by means to effect the conservation therein of the sulphur gases arising from the roasted blende, said chamber consisting of a basal floor, an upright enclosing wall and an overtop cover therefor with a draft-stack therein, a series of annularly arranged perforated tubes in said upright enclosing wall with transversely disposed passageways in the latter leading from said perforated tubes to the interior of said chamber, for the admission of steam and air thereto, tubular means exterior of the chamber, adapted to lead air and steam to said perforated tubes in the upright inclosing walls, flues leading to said chamber from the base of the furnace, and the fire boxes communicating with said flues.

353 843,825. Roasting furnace.—**Frank Klepetko**, New York, N. Y. Filed Sept. 6, 1904. Issued Feb. 12, 1907. 15 claims.

354 851,639. Process of producing zinc sulphate directly from the ore.—**George O. Angell**, Philadelphia, Pa. Filed Nov. 12, 1904. Issued April 30, 1907.

The process of producing soluble sulphates of zinc and copper direct from zinciferous ores containing sulphides of those metals, which consists in roasting the ore in a suitably chambered furnace to liberate its sulphurous constituent as gaseous sulphur oxides, shutting off applied heat and substantially closing the chamber at this stage, conserving and burning said gases therein in steam saturated suspension and in the presence of oxygen derived from air admitted to such a chamber, to form sulphuric anhydrid to act upon the zinc and copper oxides present in the charge; and finally separating out the resulting soluble sulphates from the charge, in an aqueous solution.

355 858,667. Art of treating ores.—**Robert McKnight**, Pittsburg, Pa. Filed Aug. 28, 1906. Issued July 2, 1907.

The art of reducing ores that contain elements rendering the same refractory, which consists in roasting a mixture of ground ore and salt by means of a superheated oxygen containing gas having a temperature of about 500° C. on entering the furnace; the salt being in sufficient quantity to furnish sufficient sodium to substantially convert the elements rendering the ore refractory, in its crude state into oxyalts of sodium, roasting and agitating the mix-

ture of ore and salt, and simultaneously directing upon the same, a superheated oxygen containing a gas having a temperature of about 500° C., continuing the roast until the elements rendering the ore refractory are thoroughly oxidized and metallic chlorides of metal contained in the ore are produced, collecting and condensing these volatile chlorides when volatilized, and treating the residue of the ore by amalgamation.

- 356 870,690. Method of roasting sulphurous ores.—**Adolf Savelsberg**, Aachen, Germany. Filed Sept. 17, 1906. Issued Nov. 12, 1907.

A method of roasting sulphurous ores consisting in roasting the crude ore in a converter in the presence of a substance (limestone) which, after being heated swells up in contact with water, and thereby partially desulphurizing the same, adding water to the mass thus obtained and thereby destroying the structure resulting from the sintering of the same and roasting the mass again under the action of a blast in a converter. 6 claims.

- 357 888,502. Rotary furnace applicable for use in roasting ores or the like.—**Woldemar Hommel**, Lee, England. Filed Nov. 23, 1907. Issued May 26, 1908.

- 358 915,531. Mechanical roasting furnace.—**Roman Von Zelewski**, Engis, Belgium. Filed June 15, 1908. Issued March 16, 1909.

A mechanical roasting furnace comprising a furnace body, a charge-chamber in said furnace body for pre-roasting the ore and a plurality of finish-roasting-chambers for finish-roasting the pre-roasted ore arranged independently of each other and communicating with said charge-chamber. 8 claims.

- 359 916,234. Furnace.—**Utley Wedge**, Ardmore, Pa. Filed October 24, 1906. Issued March 23, 1909. 9 claims.

- 360 926,942. Roasting furnace.—**Hascal A. Hogel**, New York, N. Y. Filed July 27, 1905. Issued July 6, 1909.

- 361 927,389. Stirring and conveying device for furnaces.—**Utley Wedge**, Ardmore, Pa. Filed Oct. 26, 1908. Issued July 6, 1909.

- 362 930,254. Ore-roasting furnace.—**Arthur R. Wilfley**, Denver, Colorado, assignor of one-half to Joseph Seep, Titusville, Pa. Filed Nov. 7, 1906. Issued Aug. 3, 1909.

- 363 939,880. Roasting and like furnace.—**Uteley Wedge**, Ardmore, Pa. Filed Nov. 29, 1907. Issued Nov. 9, 1909.

- 363a 939,881. Roasting furnace.—**Utley Wedge**. Filed Feb. 24, 1909. Issued Nov. 9, 1909.

- 364 939,934. Furnace.—**Utley Wedge**, Ardmore, Pa. Filed Feb. 24, 1909. Issued Nov. 9, 1909.

- 365 939,936. Roasting-furnace.—**Arthur R. Wilfley**, Denver, Colo., assignor of one-half to Joseph Seep, Oil City, Pa. Filed Feb. 19, 1907. Issued Nov. 9, 1909.
- 366 945,522. Ore-roasting furnace.—**Benjamin Hall**, Nevada City, Cal. Filed May 5, 1909. Issued January 4, 1910.
- 367 946,178. Furnace.—**Utley Wedge**, Ardmore, Pa. Filed April 16, 1908. Issued Jan. 11, 1910.
- 367a 947,399. Process for the preparation for zinc oxide for reduction.—**Hermann Pape**, Hamburg, Germany. Filed Mar. 29, 1909. Issued Jan. 25, 1910.
- Process of preparing zinc oxide for reduction and transport, consisting in feeding zinc oxide, in the loose condition in which it is obtained from dust chambers or filtering apparatus, into a furnace, and subjecting said oxide, while retained in the furnace, to a temperature of at least 1000° C. and until coagulated into dense, hard and heavy lumps mixed with hard granules.
- 368 966,277. Ore-roasting furnace.—**Utley Wedge**, Ardmore, Pa. Filed Oct. 18, 1909. Issued August 2, 1910.
- 369 968,265. Roasting furnace.—**Cyrus Robinson**, New York, N. Y. Filed Sept. 7, 1902. Issued August 23, 1910. 60 claims.
- 370 968,313. Rotary furnace.—**David Baker**, Philadelphia, assignor to Ladd and Baker, Inc. Filed Mar. 23, 1908. Issued August 23, 1910. 17 claims.
- 371 969,927. Ore-roaster.—**Arthur R. Wilfley**, Denver, Colo., assignor of one-half to Joseph Seep, Scranton, Pa. Filed Dec. 11, 1908. Issued Sept. 13, 1910. 8 claims.
- 372 976,175. Ore-roasting furnace.—**John F. Herreshoff**, New York, N. Y., assignor to Nichols Copper Co., New York. Filed July 20, 1909. Issued Nov. 22, 1910.
- 373 976,525. Treating sulphides or sulphates.—**Utley Wedge**, Ardmore, Pa., assignor to the Furnace Patent Co., Philadelphia, Pa. Filed Jan. 20, 1909. Issued Nov. 22, 1910.
- In the process of desulphurizing, by roasting, ores containing sulphides or sulphates, the mode of facilitating the removal of the sulphur during the later stage of the process, said mode consisting in heating the metal-bearing material during this stage of the process without direct access of the heating gases thereto, and adding to said metal bearing material a reagent whereby any sulphates which may be present will be reduced and the elimination of the sulphur effected without the application of an objectionably high degree of heat. 15 claims.

- 374 976,769. Annular ore-roasting kiln.—**John Zellweger**, St. Louis, Mo. Filed Jan. 14, 1910. Issued Nov. 22, 1910. 26 claims.

- 375 979,349. Furnace for roasting ores.—**Xavier de Spirlet**, Brussels, Belgium. Filed April 30, 1910. Issued December 20, 1910.

An ore roaster comprising in combination a series of superposed plates of refractory material spaced apart from each other to form intervening chambers, said plates having openings for successive delivery of one plate to the next lowermost plate, said plates having means for moving the material toward said openings, means for moving certain of said plates with respect to the remaining plates and means forming closed joints at the outer margins of said plates. Patented also in England, No. 10,782 of 1910; in France, No. 415,338.

- 376 980,717. Stirring device for furnaces.—**Utley Wedge**, Ardmore, Pa., assignor to The Furnace Patent Company, Philadelphia. Filed Jan. 3, 1910. Issued Jan. 3, 1911. 27 claims.

- 376a 981,880. Process for roasting sulphide ores.—**Charles W. Renwick**, Isabella, Tenn. Filed May 14, 1910. Issued January 17, 1911.

The improved process for roasting metallic sulphide ores, which consists in passing the ores downward through a series of hot roasting ovens, introducing air or oxygen into the lowermost of said series of ovens and causing it to pass upward through said ovens to the uppermost of them, and then reversing the current of said gases from the said upper oven and carrying the said gases downward and reintroducing the same into lower ovens of said series.

- 377 1,002,401. Production of zinc oxide from ores and zinc residues.—**Waldemar Hommel**, London, England, assignor to Metals Extraction Corporation, Ltd., London. Filed Nov. 30, 1908. Issued Sept. 5, 1911.

The process of recovering zinc from waste zinc furnace distillation residues containing carbonaceous matter, and simultaneously extracting zinc from fresh zinc ore, which consists in roasting the ore, mixing it with the zinc residues containing sufficient carbon to effect the reduction of all the zinc in the mixture, igniting the mixture so as to blow off the zinc (which burns to form zinc oxide) in admixture with other metallic matter, collecting the product thus volatilized, treating it with a solution of sulphurous acid so as to obtain a solution of bisulphite of zinc and precipitating the zinc as insoluble monosulphite which is then calcined to produce zinc oxide. Patented also in England, No. 27,020 of 1909.

- 378 1,017,839. Recuperative zinc ore roaster.—**John Zellweger**, St. Louis. Issued Feb. 20, 1912.
—Described in Met. & Chem. Eng., vol. 10, p. 307, May, 1912.

- 379 1,038,408. Furnace for roasting sulphide ores.—**C. C. Meigs**, Woodberry, N. J. Issued Sept. 10, 1912.
—Described in *Met. & Chem. Eng.*, vol. 10, pp. 697-98, Oct., 1912.
- 380 1,040,071. Roasting furnace with heat-equalizing chambers.—**Utley Wedge**. Issued Oct. 1, 1912.
—Described in *Met. & Chem. Eng.*, vol. 10, p. 817, Dec., 1912.
- 381 1,061,447. Method of obtaining zinc oxide and sinter from alloys containing zinc.—**Harvey M. Burkey**, Newark, N. J., assignor to Metallurgical Company of America, New York, N. Y. Filed Feb. 29, 1912. Issued May 13, 1913.
The method of recovering zinc from turnings and other waste metal alloys containing it, which consists in mixing the turnings or the like with fine coal, and igniting and blowing the mixture under temperature conditions which will leave a residual sinter and recovering the zinc as zinc oxide.
—Described in *Met. & Chem. Eng.*, vol. 11, p. 414. July, 1913.
- 382 1,069,179. Process of roasting ores and recovering zinc therefrom.—**Charles J. Reed**, Philadelphia, Pa., Filed June 3, 1912. Issued Aug. 5, 1913.
The process of recovering metals from metallic sulphides, which consists in reducing them to a fine powder, mixing the powder with a metallic oxide, subjecting the mixture to the joint action of heat and an oxygen-containing fluid, dissolving the resulting sulphate, and recovering the metal from the solution.
- 383 1,070,490. Roasting furnace.—**Frederick Laist**, Anaconda, Mont. Filed Dec. 23, 1912. Issued Aug. 19, 1913.
In combination with a furnace having a series of superimposed inter-communicating hearths, means for subjecting the charge to an oxidizing roast under direct fire in the hearths forming the upper members of the series, the hearths forming the lower members of the series serving as chloridizing hearths, and means for maintaining a pressure differential between the direct-fired hearth and the adjacent chloridizing hearth.
- 384 1,072,920. Zinc ore roasting furnace, mechanically rabbled, with tripping device for automatically stopping the rabbles.—**Francis Curnow**, Pittsburg, Kans. Issued Sept. 9, 1913.
—Described in *Met. & Chem. Eng.*, vol. 11, p. 658, Nov., 1913.
- 385 1,077,010. Improvement in ore (blende) roasting furnaces.—**Xavier de Spirlet**, Belgium. Issued Oct. 28, 1913.
—Described in *Met. & Chem. Eng.*, vol. 11, p. 716. Dec., 1913.

- 386 1,082,599. Process of chloridizing ores.—**Augustus D. Ledoux**, Summit, N. J. Filed August 13, 1912. Issued December 30, 1913.

The process of chloridizing ores, which consists in successively feeding the ore into and through a furnace, heating the initial part of the charge to induce therein chemical reaction, and thereafter inducing chemical reaction in the following portions of the charge by the heat of the established reaction in the furnace.

- 387 1,083,252. Process of desulphurizing and briquetting ores.—**William A. Hall**, New York. Filed June 27, 1913. Issued December 30, 1913.

A process of desulphurizing sulphide ore, which comprises subjecting a moving body of said ore, to a non-oxidizing flame projected downwardly thereupon, whereby sulphur is driven off in the elemental condition, and withdrawing the vaporous products from below said body of ore.

- 388 1,094,953. Metallurgical furnace.—**Utley Wedge**, Ardmore, Pa. Filed June 19, 1912. Issued April 28, 1914.

- 389 1,094,954. Metallurgical furnace.—**Utley Wedge**, Ardmore, Pa. Filed July 16, 1913. Issued April 28, 1914. 9 claims.

- 390 1,112,853. Manufacture of zinc oxide.—**James A. Singmaster**, Palmerton, Pa., assignor to New Jersey Zinc Co. Filed Jan. 9, 1912. Issued Oct. 6, 1914.

Process of forming sublimed zinc oxide and analogous products, which consists in forming a bed or layer comprising a reducible compound of the zinc or other relatively volatile metal and combustible material, igniting such bed, advancing the same during its combustion through a suitable chamber, simultaneously transmitting a combustion-supporting draft-current through the bed, and collecting the effluent from such bed at successive points along its path of movement. 10 claims.

- 391 1,112,854. Apparatus for the manufacture of zinc oxide.—**James A. Singmaster**, Palmerton, Pa., assignor to New Jersey Zinc Company. Filed Jan. 18, 1912. Issued October 6, 1914.

A subliming furnace comprising a refractory tunnel structure, a traveling grate surface adapted to move therein, means for transmitting combustion-supporting gas through said traveling grate surface, and a plurality of fume off-takes connected with said structure at intervals along the length thereof. 31 claims.

- 392 1,114,372. Process of roasting ores.—**Frederick Laist**, Anaconda, Mont. Filed Nov. 22, 1913. Issued Oct. 20, 1914.

In the treatment of ores and other material, the process of subjecting a charge of the ore while traversing a treatment chamber to the action of hot reaction-supporting gases, introducing said gases in a direction conforming to the general direction of movement of the ore in said chamber to prevent overheating of the charge removing the resulting hot calcines from the influence of the said gases, com-

- 393 1,137,371. Roasting-furnace.—**Frederick Laist**, Anaconda, Mont. Filed Oct. 15, 1913. Issued Oct. 20, 1914. 6 claims.
- 394 1,119,483. Metallurgical furnace.—**Utley Wedge**, Ardmore, Pa. Filed Feb. 28, 1914. Issued December 1, 1914.
- 395 1,121,226. Dry treatment of ores.—**Wilhelm Buddeus**, Charlottenburg, Germany. Filed February 5, 1914. Issued December 14, 1914.

The treatment of zinc blende ore, containing blende and similar metallurgical products, consisting in mixing the finely divided or disintegrated material with a binding agent such as calcium silicate forming it into briquets and roasting the briquets with fuel in the presence of an air current, and finally directing a burning gas current against the briquets. Patented also in England, No. 29,042 of 1913; in France, No. 466,397.

- 396 1,131,691. Process for desulphurizing ores.—**Giovanni Fusina**, Genoa, Italy. Filed April 25, 1912. Issued March 16, 1915.

A process for desulphurizing ores which consists in passing a quantity of air through the material in one direction, and then passing a quantity of air and steam through said material in the opposite direction.

- 397 1,132,684. Roasting of compounds or ores containing zinc.—**Augustin L. J. Queneau**, Philadelphia, Pa. Filed July 19, 1911. Issued March 23, 1915.

The method of dead-roasting zinc blende, which consists in introducing the blende into a roasting chamber, maintaining an oxidizing roasting atmosphere therein while keeping the charge in agitation, heating the lining of the roasting chamber by an electric current and thereby maintaining the temperature of the charge at the roasting point for zinc blende and establishing neutral conditions between the lining and charge during the roasting operation. Patented also in England, No. 15,460, of 1912; in France, No. 445,233; in Germany, No. 288,648. See item 280.

- 398 1,133,068. Rake-operating mechanism for ore-roasting furnaces.—**John J. Simmonds**, Iola, Kans., assignor to the Simmonds Engineering Company, Iola. Filed July 16, 1914. Issued March 23, 1915.

- 399 1,142,795. Production of zinc sulphate.—**Ramon Bonastre Llopart**, Cordoba, Argentina. Filed April 2, 1915. Issued June 15, 1915.

The method of producing zinc sulphate which consists in mixing a blende comprising zinc sulphide and sulphide of iron with substances containing zinc and oxygen, heating them to 400° to 500° C. in air free from strong currents. 6 claims.

- 400 1,143,438. Ore roasting or drying furnace.—**Harry Mackenzie Ridge**, London, England. Filed October 6, 1913. Issued June 15, 1915. 7 claims.

—Described in Eng. & Min. Jour., vol. 100, p. 271. Aug. 14, 1915.

- 401 1,154,601. Extraction, purification, and electrolytic precipitation of metallic zinc from smelter-fumes, zinc ores and the like.—**Otto Best**, San Francisco, Cal. Filed Sept. 16, 1911. Issued, Sept. 28, 1915.

In the extraction of metallic zinc from zinc fumes, or the like, the preliminary step of obtaining a zinc salt suitable for forming the electrolyte, which comprises subjecting the fumes to a purifying roast, in the presence of sulphates, at a low temperature, thereby rendering the fumes filterable, and leaching with a small excess of sulphuric acid.

- 402 1,162,532. Metallurgical furnace.—**Utley Wedge**, Ardmore, Pa. Filed May 3, 1911. Issued November 30, 1915.

—Described. Min. & Sci. Press, vol. 112. p. 246. Feb. 12, 1916.

—Described. Jour. Soc. Chem. Ind. vol. 35. p. 124. Jan. 31, 1916.

pleting the treatment of the calcines thus removed without further application of heat and conducting the gases from the final treatment, to the charge traversing the treatment chamber aforesaid. 8 claims.

- 403 1,162,533. Metallurgical furnace.—**Utley Wedge**, Ardmore, Pa. Filed Oct. 23, 1912. Issued November 30, 1915.

- 404 1,162,534. Metallurgical furnace.—**Utley Wedge**, Ardmore, Pa. Filed Oct. 22, 1913. Issued November 30, 1915.

- 405 1,169,444. Treating metallic sulphides.—**Utley Wedge**, Ardmore, Pa. Filed June 5, 1913. Issued Jan. 25, 1916.

The continuous process of producing metal from sulphur compounds containing the same consisting in first subjecting the compound at a temperature sufficient to vaporize the sulphur, to an atmosphere containing a reagent which will oxidize the metal without promoting the oxidation of the sulphur, and then continuing the subjection of the oxide thus formed to a reducing atmosphere at a temperature sufficient to convert the oxide to metallic form.

—Described in Min. & Sci. Press. vol. 112, p. 484. Apr. 1, 1916.

—Described in Jour. Soc. Chem. Ind. vol. 35, p. 315. Mar. 15, 1916.

- 405 1,170,375. Treating ores.—**Utley Wedge**, Ardmore, Pa. Filed Oct. 7, 1911. Issued Feb. 1, 1916.

—Described. Jour. Soc. Chem. Ind. vol. 35, p. 364. Mar. 31, 1916.

- 407 1,170,376. Metallurgical furnace.—**Utley Wedge**, Ardmore, Pa. Filed Jan. 15, 1913. Issued Feb. 1, 1916.

—Described. Jour. Soc. Chem. Ind. vol 35, p. 364. Mar. 31, 1916.

- 408 1,171,583. Ore-roasting apparatus.—**Harrison T. Benson**, Denver, Colo., assignor of one-half to **Winfield S. Barnes**, Philadelphia, Pa. Filed Aug. 11, 1915. Issued Feb. 15, 1916.

- 409 1,172,321. Process for recovering zinc from zinciferous materials.—**Friedrich Carl Wilhelm Timm**, Hamburg, Germany. Filed Oct. 7, 1913. Issued Feb. 22, 1916.

The process for recovering zinc from zinciferous materials which consists in causing gas containing free oxygen to pass through a hot mixture of zinciferous materials and solid carbonaceous substances during a comparatively short time, then withdrawing the mixture from the effect of the gas passing through it, then re-arranging the mixture in a practically even density, then causing the free oxygen-containing gas to pass again through the mixture and repeating this working whereby the zinc is freed from the zinciferous materials in different periods, the heat produced by passing the free oxygen-containing gas through the mixture being so regulated as to produce an un-molten, sintered residue. Patented also in England, No. 22,519 of 1913; in France, No. 463,330; in Germany, No. 268,427.

—Described in Met. & Chem. Eng., vol. 14, p. 666. June 1, 1916.

- 410 1,172,470. Ore-roasting furnace.—**William H. Motter**, Denver, Colo. Filed May 19, 1913. Issued Feb. 22, 1916.

- 411 1,173,354. Water-cooled hollow shaft for ore-roasting furnaces.—**Ernst Jensen-Valdal**, Copenhagen, Denmark, assignor to Aktieselskabet Dansk Svovlsyre- & Superphosphat-Fabrik, Copenhagen, Denmark. Filed Jan. 3, 1912. Issued Feb. 29, 1916.

- 412 1,181,183. Roasting of sulphur bearing ores.—**Harry H. Stout**, New York, N. Y., assignor to General Chemical Company, New York. Filed July 31, 1914. Issued May 2, 1916.

413. 1,181,184. Roasting furnace for sulphur-bearing ores.—**Harry H. Stout**, New York N. Y., assignor to General Chemical Company, New York. Filed July 31, 1914. Issued May 2, 1916.

- 414 1,183,172. Process of roasting zinc-blende.—**Charles A. H. De Saullès**, New York, N. Y. Filed Oct. 17, 1914. Issued May 16, 1916.

The method of treating zinc blende for recovering metallic zinc which comprises roasting the blende, adding carbon to the roasting charge at the latter end of the roasting operation and regulating the air admission so as to produce a temperature not exceeding 1,000°

C. and thereby obtaining a reduction and dissociation of the sulphates present without volatilizing any of the metals, and finally treating the resultant roast in a suitable furnace to reduce the zinc to a metallic state.

—Described in Jour. Soc. Chem. Ind. vol. 35, p. 744. July 15, 1916.

- 415 1,195,424. Roasting Furnace.—**Utley Wedge**, Ardmore, Pa., assignor to The Furnace Patent Company, Philadelphia. Filed Jan. 20, 1916. Issued August 22, 1916. 16 claims.

—Described. Jour. Soc. Chem. Ind. vol. 25, p. 1067. Oct. 31, 1916.

- 416 1,195,425. Metallurgical furnace.—**Utley Wedge**, Ardmore, Pa., assignor to The Furnace Patent Company, Philadelphia. Filed June 24, 1911. Issued Aug. 22, 1916.

—Described. Jour. Soc. Chem. Ind. vol. 25, p. 1067. Oct. 31, 1916.

- 417 1,208,246. Furnace and allied structure.—**Utley Wedge**, Ardmore, Pa. Filed Jan. 12, 1914. Issued December 12, 1916.

—Described. Jour. Soc. Chem. Ind. vol. 36, p. 142. Feb. 15, 1917.

- 418 1,208,247. Furnace.—**Utley Wedge**, Ardmore, Pa. Filed Feb. 11, 1914. Issued Dec. 12, 1916.

- 419 1,208,248. Feeding device for furnaces.—**Utley Wedge**, Ardmore, Pa. Filed Feb. 28, 1914. Issued Dec. 12, 1916.

- 420 1,208,249. Metallurgical furnace.—**Utley Wedge**, Ardmore, Pa. Filed Nov. 21, 1914. Issued Dec. 12, 1916.

- 421 1,208,250. Metallurgical furnace.—**Utley Wedge**, Ardmore, Pa. Filed Mar. 1, 1915. Issued Dec. 12, 1916.

- 422 1,210,852. Mechanical roasting furnace.—**Wilhelm Schefczik**, Hamborn-on-the-Rhine, Germany. Filed May 22, 1914. Issued January 2, 1917.

- 423 1,213,922. Zinc-furnace.—**George Londress** and **Leyland Rogers**, Clarksburg, W. Va. Filed June 27, 1914. Issued Jan. 30, 1917.

A zinc dross furnace comprising a series of fire boxes, a dross compartment and a spiral flue surrounding said dross compartment and communicating with and connecting each of said fire boxes.

—Described in Jour. Soc. Chem. Ind. vol. 36, p. 343-44. Mar. 31, 1917.

- 424 1,258,934. Process of extracting metals from their ores.—**Charles C. Nitchie**, Depue, Ills., assignor to The New Jersey Zinc Company, New York. Filed Nov. 19, 1915. Issued March 12, 1918.

The method of treating ores, fumes and other metalliferous material containing lead, zinc and iron, which comprises heating such material with ammonium sulphate to a temperature sufficient to convert the zinc and iron into sulphates and to drive off the ammonia, then heating to a higher temperature to decompose the iron sulphate without decomposing the zinc sulphate, and extracting the zinc sulphate from the resulting product, whereby a zinc sulphate solution is obtained relatively free from lead, and iron and a lead-containing residue is obtained substantially free from zinc.

—Described in *Met. & Chem. Eng.* vol. 18, p. 550. May 15, 1918.

- 425 1,273,844. Process for roasting ore.—**Charles H. Fulton**, Cleveland, Ohio, assignor to Metallurgical Laboratories, Inc., Chicago, Ill. Filed Aug. 19, 1916. Issued July 30, 1918.

A process of roasting finely divided sulphide ores comprising forming a mixture of pulverized ore and preheated air thereby raising the temperature of the ore to the ignition point, conveying such mixture of air and ore together slowly while maintaining the suspension and temperature of the ore until the required degree of desulphurization is attained and then separating the ore from gases and air. 11 claims.

Great Britain

- 426 12,512 of 1899. Process for roasting sulphide ores.—**E. C. H. Pape** and **C. A. L. W. Witter**, Hamburg, Germany.

Roasting mixed sulphides in a powdered form sprayed into contact with the heating furnace.

- 427 16,161 of 1899. Furnace for sulphide ores.—**J. Armstrong**, London.

"Improved form of reverberatory furnace for the inventor's process for treating zinc-lead sulphide ores."

- 428 16,312 and 16,388 of 1899. Treatment of zinc-lead sulphides.—**J. Armstrong**, London.

Modifications on the inventor's process for treating zinc-lead sulphides and its special application for zinc alone.

- 429 21,213 of 1899. Roasting furnace.—**W. A. Koneman** and **W. H. Hartley**, London.

"A roasting furnace where the heating gases are drawn through the ore by suction."—**E. & M. J.**

- 430 10,105 of 1901. Improved process for the treatment of mixed ores and compounds, for the extraction or separation of lead and zinc therefrom.—**C. H. T. Haverman**, Paris. Issued May 15, 1901.

"Mixed ores or sludges are mixed with carbon and heated in a reverberatory furnace connected to condensation chambers....."—**J. S. C. I.**

- 431 5,016 of 1903. Roasting blende.—**A. Kunze** and **K. Danziger**, Kattowitz, Silesia.

Roasting mixed blende and pyrite in such a way that the pyrite oxidizes before the blende, then removing the iron by leaching, after which the blende is more fit for the zinc furnace.

- 432 22,900 of 1905. Roasting process.—**E. Enke**, Kattowitz, Silesia.

"In sulphatizing ores, especially zinc ores, adding acid sodium sulphate, and heating the mixture with the exclusion of air to a temperature just sufficient to decompose the ferrous sulphate."—**E. & M. J.**

- 433 4,199 of 1906. Zinc roasting ores.—**L. Brunet**, Paris.

"Method of roasting complex zinc ores so that sulphate of zinc is formed; then dissolving out with sulphurous acid and acting on barite so as to produce a lithopone paint, consisting of sulphite of baryta and oxide of zinc."—**E. & M. J.**

- 434 5,655 of 1906. Metallurgy of zinc.—**H. A. Leaver** and **C. Buch**, London.

"Improved process for recovering zinc oxide from flux skimmings of zinc by means of lime."—**E. & M. J.**

- 435 3,374 of 1907. Mechanical roasting furnaces for roasting zinc sulphide, etc.—**A. Landsberg** and **A. Roitzheim**, Stolberg, Germany.

- 436 12,708 of 1915. Mechanical roasting furnaces.—**A. Zavelberg**, Hohenlohehuetten, Germany.

—Described in *Jour. Soc. Chem. Ind.* vol. 35, p. 1161. Nov. 31, 1916.

- 437 100,259 of 1916. Automatic charging devices for roasting and like furnaces.—**A. Mond**, London. From *Metallbank und Metallurgische Ges.*, Frankfurt, Germany.

—Described in *Jour. Soc. Chem. Ind.*, vol. 36, p. 203, Feb. 28, 1917.

Germany

- 438 299,528. Process of desulphurizing zinc ores.—**Aktien-Gesellschaft f. Bergbau, Blei- und Zinkfabrikation zu Stolberg**. Sept. 1, 1908.

"The feature of the process is the combined use of a blast, and movement of the ore during roasting."—**J. S. C. I.**

- 439 236,089. Mechanical roasting furnace with several horizontal, circular, super-imposed roasting chambers, connected with each other alternately at the circumference and in the center.—**Xavier de Spirlet**, Brussels, Belgium. April 29, 1910.

- Described. *diagr. Zeits. f. angewandte Chem.*, vol. 24, p. 1493. Aug. 4, 1911.
- 440 237,034. Process for the complete roasting of zinc blende and other sulphide ores.—**R. G. Max Liebig**, Godesburg-am-Rhein, Germany. June 11, 1910.
“To completely desulphurize zinc blende, it is necessary to apply additional heat towards the end of the roasting. According to the present patent, highly heated air is led directly over the ore.”—**J. S. C. I.**
- Described in *Zeits. f. angewandte Chem.*, vol. 24, p. 1653. Sept. 1, 1911.
- 441 242,312. Process for oxidizing roasting of sulphide zinc ores in combustion gases containing oxygen and aqueous vapors.—**W. Borchers**, Aix-la-Chapelle, **Rudolph Schenck**, Breslau, and **Felix Thomas**, Aix-la-Chapelle. May 13, 1910.
- Described in *Zeits. f. angewandte Chem.*, vol. 25, p. 282. Feb. 9, 1912.
- Described in *Jour. Soc. Chem. Ind.*, vol. 31, p. 237. Mar. 15, 1912.
- 442 244,131. Rotary tubular oven for the roasting of zinc ores. **Paul Schmieder**, Lipine, Upper Silesia, Germany. May 26, 1910.
- Described in *Zeits. f. angewandte Chem.*, vol. 25, p. 640. Mar. 29, 1912.
- 443 278,443. Process for the roasting of blende ores or smelter products on a movable grate.—**Wilhelm Buddeus**, Charlottenburg, Germany. Feb. 27, 1913.
The blende is briquetted with a salt, which prevents the disintegration of the briquet during roasting.
- 444 286,620. Sulphatizing roasting of ores and metallurgical products.—**Wilhelm Buddeus**, Charlottenburg, Germany. Sept. 7, 1913.
- Described in *Jour. Soc. Chem. Ind.*, vol. 35, p. 185. Feb. 15, 1916.
- 444a 306,790. Continuous process for the chloridizing roasting of zinc and copper bearing ores and residues in the blast furnace.—**Wilhelm Buddeus**, Berlin. Issued July 10, 1918.
- Described in *Zeits. f. angewandte Chem.*, vol. 31, p. 367. Dec. 13, 1918.



LEACHING DIVISION, GREAT FALLS ELECTROLYTIC ZINC PLANT, ANACONDA COPPER MINING CO.
The black building in the right center is the Dryer Division, containing rotary dryers for drying the residue from the leaching Division. The monitor or the Electrolyzing Division is visible in the left foreground.

See also under Electrolytic Zinc, as nearly all the articles on electrolysis include descriptions of leaching methods.

Bibliography

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Bisulphite Process

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- 509 Verarbeitung zinkarmer Erze, besonders von Galmei. Metallurgie, vol. 9, pp. 309-10. May 8, 1912.
Working up carbonate ores of low zinc content, leaching with sulphurous acid, and smelting. German patent 238,292, by Gilbert Dantin, Lyons, France.
- 510 Verfahren zum Auslaugen von zinkhaltigen Stoffen mit Chlor bei Gegenwart von Kohle. Metallurgie, vol. 7, pp. 284-85. May 8, 1910.
Method of leaching zinc-bearing materials with chlorine, in the presence of carbon. German Patent 216,361, by Guido Mojana, Milan, Italy.
- 511 Verfahren zur Erzeugung von reinem Zinkoxyd oder reinem metallischen Zink durch Behandlung gereinigter Loesungen von Zinksalzen mit Ammoniumsulfits unter Regenerierung des verwendeten Ammoniumsulfits und Gluehen des erhaltenen Zinksulfits. Metall u. Erz. vol. 12, pp. 299-300. July 22, 1915.

German patent 285,617; by H. W. de Stucklé. Process for the production of pure zinc oxide, or pure metallic zinc by working refined solutions of zinc salts with ammonium sulphite, with regeneration of the used ammonium sulphite and calcination of the zinc sulphites.

- 512 Verfahren zur Verarbeitung von Silber-Blei-Zinkerzen durch Schmelzen derselben mit Chlorzink oder seinen Doppelsalzen und Faellen des Bleis aus waessriger Loesung. Metall u. Erz., vol. 11, pp. 432-33. June 22, 1914.

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- 513 Zinc chloride from zinc-bearing ores. Met. & Chem. Eng., vol. 18, p. 550. May 15, 1918.

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- 514 Zinc digester and filter. diagr. Met. & Chem. Eng., vol. 11, p. 54. Jan., 1913.

P. C. C. Isherwood's patent 1,043,939. "The operation is similar in many respects to that of a chlorination barrel, but is only one step in a process which involves solution of zinc in sulphuric acid, and ultimate electrolysis."

- 515 Zinc, gold silver from ores. Electrochem. & Met. Ind., vol. 4, p. 35. Jan., 1906.

Nicholas's Patent 805,577. Treatment of ores, mattes, slimes, etc., by mixture with water and sodium chloride, forming zinc chloride, which is leached.

- 516 Zinc hydrometallurgy. Eng. & Min. Jour., vol. 97, p. 809. Apr. 18, 1914.

Bett's Patent 1,066,245.

- 517 Zinklaugerei. Zeits. f. Elektrochem., vol. 3, pp. 13-14. July 5, 1896.

German Patent 87,398, by Carl Hoepfner. Zinc leaching. The ore is roasted to oxide; sulphuric acid and calcium chloride are added, forming zinc chloride, which is satisfactory for electrolysis.

PATENTS ON LEACHING

United States

- 518 444,997. Process of treating zinc ores.—William West, Denver, Colo. Filed December 13, 1889. Issued January 20, 1891.

The process of eliminating zinc from complex ores, which consists in roasting the ore to form sulphurous acid gas and oxidize the zinc, then cooling this gas to a temperature of 180° F. or below and passing the same in gaseous form in conjunction with steam and without oxidation into sulphuric acid through a previously roasted charge to form soluble sulphite of zinc and then immediately leach-

ing out and separating the zinc sulphite with water at a temperature below 180° F.

- 519 457,256. Process of obtaining sulphate of zinc from zinciferous ores.—**Charles F. Croselmire**, Newark, N. J. Filed March 31, 1888. Issued August 4, 1891.

That improvement in the process of obtaining sulphate of zinc from zinciferous ores where iron and alumina are present, which consists in pulverizing the ore and roasting it, placing it in a dilute acid solution, and then injecting into or through said solution steam, superheated steam, or hot air with chloride of lime for the purpose of depositing any trace of iron or alumina that may be present.

- 520 489,873. Method of producing zinc oxide from sulphite or sulphate of zinc.—**Robert F. Nenninger**, Newark, N. J. Filed Sept. 21, 1892. Issued Jan. 10, 1893.

The method of recovering oxide of zinc from a solution of sulphate or sulphite of zinc, which consists in precipitating with lime, collecting the precipitate and boiling it with a concentrated solution of zinc sulphate, filtering, evaporating the filtrate to dryness and finally leaching with water.

- 521 497,473. Process of treating complex or sulphide ores.—**Walter R. Ingalls** and **Francis Wyatt**, New York, N. Y. Filed Dec. 28, 1892. Issued May 16, 1893.

The process of treating complex sulphide ores, which consists first in subjecting the ore to a sulphatizing roasting and recovering the driven off sulphur in the form of sulphuric acid; second, lixiviating the roasted ore with said sulphuric acid and water, and removing the iron from the solution if necessary; third, precipitating the zinc from said solution in the form of carbonate, or carbonate and hydroxide, by the use of sodium carbonate, and subsequently converting the same into zinc oxide; fourth, evaporating the sodium sulphate obtained from the zinc sulphate solution, and heating the same with sodium chloride and coal to convert it into sodium sulphide; fifth, converting the sodium sulphide into bi-carbonate of soda by dissolving the same in water and treating the solution with carbonic acid gas and recovering the sulphur in the form of sulphuric acid as described and lastly, converting the bi-carbonate of soda into sodium carbonate by heating the same, to drive off the hydrogen and carbonic acid gas.

- 522 512,362. Process of preparing solutions carrying salts of zinc.—**Parker C. Choate**, New York, N. Y., assignor to the Electrical Zinc Co., of New Jersey. Filed June 4, 1892. Issued Jan. 9, 1894.

The process of forming a solution carrying salts of zinc which consists in forming a sulphate solution of the soluble elements of the ore and recovering the same therefrom by evaporation and crystallization, heating the crystallized product to drive off the salts of metals more volatile than zinc and convert those less volatile than zinc into compounds insoluble in water and finally treating the mass with water to dissolve the zinc element.

—Described in Met. & Chem. Eng., vol. 10, p. 62. Jan., 1912.

- 523 513,490. Process of treating zinc-lead-sulphide ores.—**Stephen H. Emmens**, London, England. Filed Nov. 28, 1892. Issued Jan. 30, 1894.

The process of treating lead sulphide ores carrying gold or silver, which said process consists in, first, finely comminuting the ore, secondly, roasting the same in an oxidizing atmosphere, thirdly, leaching out such roasted ore with water containing ferrous sulphate, fourthly, leaching such once-leached ore with an aqueous solution of ferrous and ferric sulphates, fifthly, leaching such twice-leached ore with water containing ferrous sulphate, and sixthly, removing iron from the zinc sulphate solution obtained by the first and second of the said leachings by mixing such solutions together and heating them.

- 524 516,016. Treatment of ores of zinc.—**Walter R. Ingalls** and **Francis Wyatt**, New York, N. Y. Filed October 3, 1893. Issued March 6, 1894.

The process of treating ores of zinc which consists, first in subjecting the ore to an oxidizing roasting; second, lixiviating the roasted ore with water and sulphuric acid; third, separating one fourth of the zinc sulphate solution thereby formed from the rest and precipitating the zinc from said separated portion by means of a sulphide of an alkaline base; fourth, evaporating the remainder of the zinc sulphate solution to dryness and mixing the precipitated sulphide therewith; and lastly heating the mixture in a suitable furnace whereby sulphurous anhydride gas is evolved.

- 525 518,890. Process of extracting zinc from ores.—**Ludwig Klöz**, Leadville, Colo. Filed April 24, 1893. Issued April 24, 1894.

The process of treating zinc ores which consists first, in roasting the ores, and conducting the sulphurous acid gases from the roast into a suitable tower, and absorbing them into water; second, heating the solution so formed to set free part of the sulphurous acid gas, and scattering the remainder of the solution to set free the balance of the gas; third, reabsorbing the gas so set free in water to form a concentrated solution; fourth, leaching the ores or furnace products with this solution, and fifth, scattering the resulting zinc sulphite solution with steam, to dispel the sulphurous acid and precipitate the zinc in the form of the sulphite.

- 526 541,447. Process of reducing zinc slimes.—**Hugh W. Watts** and **Alonzo Coan**, Boulder, Colo. Filed Oct. 22, 1894. Issued June 18, 1895.

Consists in first treating with dilute sulphuric acid to remove metallic zinc, washing the residue to remove the soluble salts and remaining acid, and boiling the residue thus formed with concentrated sulphuric acid to dissolve the cyanide of zinc and other salts thereof which are insoluble in the dilute acid.

- 527 544,612. Process of manufacturing zinc.—**Atkinson Crossley**, Talywain, England. Filed May 14, 1895. Issued August 14, 1895.

The process for the manufacture of zinc oxide which consists in adding sulphuric acid to the metallic ores or compounds, heating

the mixture and converting the lead present to an insoluble salt, and depositing any gold or silver present, then diluting with water and converting the other metals present to soluble salts, filtering off the clear liquor, then treating the clear acid liquor filtered off with an alkaline sulphide, precipitating the copper as copper sulphide, then filtering the liquor from the precipitate, treating with an alkali until neutral, passing chlorine into it until all manganese and iron present form manganic and ferric oxides which are thrown down by a slight excess of alkali, adding an excess of alkali to bring the zinc oxide into solution, and then precipitating the zinc oxide and filtering off the liquor therefrom.

- 528 547,587. Method of extracting zinc from complex ores.—**Carl V. Petraeus**, Joplin, Mo., assignor to Oliver P. Picher. Filed March 31, 1891. Issued October 8, 1895.

The method of separating zinc from complex ores where it is found as a sulphate or sulphite which consists in crushing the ore, roasting it, dissolving out the soluble zinc salts in water, adding a solution of sulphuric acid to dissolve out any zinc oxide, introducing live steam to the mixture of ore and solvents to thoroughly mix and heat them, separating the solution of sulphate of zinc from the insoluble parts of the ore, adding chloride of calcium to the solution to convert the zinc into a chloride, separating the solution of zinc chloride from the precipitated calcium sulphate and finally adding quick lime to the solution of zinc chloride to precipitate the zinc as zinc oxide.

- 529 570,861. Apparatus for leaching.—**Lewis D. Armstrong**, Lock Haven, Pa. Filed June 25, 1891. Issued November 3, 1896.

- 530 595,513. Method of preparing zinc ores and zinciferous ores for smelting.—**Edgar A. Ashcroft**, Grays, England. Filed March 20, 1896. Issued December 14, 1897.

The improvement in the method of preparing zinc ores and zinciferous lead ores for smelting, which consists in leaching the finely ground ore with a hot solution of ferric sulphate, thereby dissolving out the zinc and precipitating the iron as ferric hydrate in the residue to serve as a flux in the smelting operation.

- 531 602,295. Treating solutions or ores containing zinc for recovering zinc as oxides.—**Edgar A. Ashcroft**, Newcastle, New South Wales. Filed September 4, 1896. Issued April 12, 1898.

Consists (a) obtaining from the zinc bearing ore or solution solutions of sulphate; (b) adding zinc oxide and stirring the mixture until a pasty consistency is obtained; and (c) heating the resulting product for the purpose of converting it into zinc oxide, sulphurous or sulphuric acid gas being disengaged.

- 532 611,917. Treatment of zinc and copper ores.—**Walter. J. Koehler**, Broken Hill, New South Wales, assignor to the Broken Hill Proprietary Company, Ltd., Melbourne, Victoria. Filed Nov. 7, 1896. Issued October 4, 1898.

The method of treating oxidized zinc-bearing ores, which consists in heating said ores with an admixture of ammonium sulphate, thereby converting the oxides into sulphates and liberating the free ammonia-gas, then leaching by water the sulphates so obtained, and then precipitating the zinc from its solution in the form of zinc hydrate by passing through it the liberated ammonia gas and regenerating the sulphate of ammonia.

- 533 647,989. Process of extracting zinc from substances containing same.—**Thomas Ryan, Jr., Flint, and Newton Hughes**, Baglilt, England. Filed Dec. 26, 1899. Issued April 24, 1900.

The process of extracting zinc from substances containing the same consisting in subjecting the substances to the action of a caustic alkali the various steps of the dissolving being so carried out that the solution of caustic alkali is brought in contact with several successive portions of raw material, and the various portions of raw material are each successively treated with different portions of caustic solution, precipitating any lead present by galvanic action, securing the removal of organic matters and iron manganese and silicon by the addition of caustic lime and bleaching powder, and finally precipitating the dissolved zinc in the form of zinc oxide or zinc hydroxide by the addition of carbonic acid.

- 534 648,809. Process of making anhydrous zinc chloride.—**Oscar J. Steinhart, Julius L. F. Vogel, and Henry E. Fry**, London, England. Filed April 10, 1899. Issued May 1, 1900.

The process herein described of manufacturing dehydrated zinc chloride without the loss of chlorine and formation of zinc oxychloride, which consists in heating a solution of zinc chloride in an air-tight vessel and maintaining a vacuum therein until the solution is boiled, watery vapor driven off and anhydrous zinc chloride remains in a fused state with only a trace of zinc oxide.

- 535 652,072. Treatment of Ore.—**Guy de Bechi**, Paris, France. Filed Jan. 24, 1899. Issued June 19, 1900.

The method of treating complex ores, for the recovery of copper, zinc and lead consisting in subjecting the ore to a chloridizing roasting, condensing the vapors and gases evolved, treating the roasted ore and the acidulated water containing the condensed vapors and gases with calcium chloride to precipitate soluble sulphates and sulphuric acid as insoluble calcium sulphate, then lixiviating the ore with the acidulated water to obtain a solution of zinc and copper salts, and fractionally precipitating zinc and copper from the said solution as hydrated oxides by successive additions of lime, substantially as described.

- 536 654,804. Process of obtaining oxide and carbonate of zinc from materials containing zinc.—**Gilbert Rigg**, Swansea, England. Filed May 6, 1899. Issued July 31, 1900. 12 claims.

Consists in leaching the zinciferous material with a solution of ammonia and carbon-dioxide wherein the carbon-dioxide is in such proportion to the ammonia as to impart to the latter an approximately-maximum zinc-dissolving capacity.

- 537 656,497. Process for treating zinc-bearing complex ores for recovery of zinc or other metals therefrom.—**Guy de Bechi**, Paris. Filed May 1, 1899. Issued Aug. 21, 1900. 9 claims.

Consists in separately roasting the ore and an alkali chloride in the presence of air and steam, conveying the sulphurous and sulphuric vapors thus derived from the ore over and in contact with the said chloride during the roasting to obtain hydrochloric-acid fumes, condensing the acid fumes, lixiviating the roasted ore, with the acid liquor thus obtained to produce a solution of metallic chloride, and successively precipitating the metals of the metallic chloride as hydrates by successive additions of alkali.

- 538 659,338-9-40. Process of extracting zinc and copper from their ores.—**Caleb G. Collins**, New York. Filed Oct. 30, 1899. Issued Oct. 9, 1900.

The process consists in exposing the comminuted ore to the action of a solution of sodium sulphate containing sodium bisulphate, sodium chloride and hydrochloric acid (salt-cake and niter-cake solution) in proportion to the contained copper and zinc, but sufficient in strength to dissolve only copper and zinc therefrom; and subsequently recovering these metals from the solution.

- 539 663,759. Process of producing solutions of zinc chloride, etc.—**Carl Hoepfner**, Frankfort, Germany. Filed Nov. 18, 1897. Issued Dec. 11, 1900. 7 claims.

Consists in reacting upon an oxide or insoluble salt of zinc in presence of water with sulphurous acid to form soluble zinc bisulphate, precipitating from the bisulphate so obtained the insoluble monosulphite of zinc, and treating the latter with a chloride of an alkali metal to form zinc chloride.

- 540 672,637. Process of treating zinc-bearing ores for obtaining zinc, etc.—**Sherard O. Cowper-Coles**, London, England, assignor to the Cowper-Cowles Metal Extraction Syndicate, Ltd., Mellanear Haeylc, England. Filed July 23, 1898. Issued April 23, 1901.

A process for the treatment of complex zinc ores, such as those known as Broken Hill ore, consisting in crushing, screening and roasting the ore, then placing it in leaching vats, then treating it with a weak solution of sulphuric acid to abstract the zinc and copper, then passing such solution containing zinc sulphate and copper sulphate through a body of carbon and an electropositive metal to recover the copper, and then electrolyzing the remaining solution to recover the zinc.

- 541 678,210. Process of treating complex ores.—**James W. Worsey**, St. Helen's, England. Filed Sept. 17, 1900. Issued July 9, 1901.

Process for the production of zinc oxide from the complex sulphide ores, comprising partial removal of the sulphur by calcination of the ore, mechanical disintegration of the ore, addition of sodium nitrate to the ore, formation of zinc sulphate by boiling the ore with dilute sulphuric acid, roasting the product in a closed furnace, lixi-

viation of the roasted product with weak sodium-sulphate solution, removal of copper where present from the sodium-sulphate solution, precipitation of the zinc from the said solution by means of lime and sublimation of the zinc in an oxidizing atmosphere.

- 542 682,794. Process of obtaining zinc solutions free from iron and manganese compounds.—**Friedrich A. Gasch**, Hönningen-on-the-Rhine, Germany. Filed Dec. 19, 1899. Issued Sept. 17, 1901.

The process of obtaining zinc solution substantially free from iron and manganese, which consists in treating zinciferous roasted pyrites with concentrated sulphuric acid and roasting the product resulting therefrom at about a temperature of 400° C., and mixing it while still hot with a suitable oxidizing agent and finally leaching the mixture.

- 543 695,306. Separation of the constituents of complex sulphide ores.—**Max M. Haff**, New York, N. Y., assignor to the Ampere Electro-Chemical Co., Jersey City. Issued March 11, 1902.

The process consists in heating mixed sulphides of zinc and lead with sulphate of an alkali metal, treating the resultant mass with a dissolving agent to dissolve the zinc sulphate and the alkali-metal sulphate, while leaving the lead sulphate undissolved and adding barium hydrate to the mixed solution to precipitate zinc hydrate and barium sulphate.

- 544 697,898. Process of purifying zinc-bearing ores.—**Carl R. P. Steinau**, Cleveland, Ohio. Filed Jan. 12, 1901. Issued April 15, 1902.

The process of purifying zinc-bearing solutions containing copper, lead, arsenic, cadmium and other metals kindred with zinc, which consists in treating such solutions with zinc powder, that is to say, with a mixture of about seventy-five parts of zinc and about twenty parts of zinc oxide, to precipitate the copper, lead, arsenic and cadmium, and to simultaneously reduce the amount of any free acid the solution may contain.

- 545 704,036. Process of separating alkali-metal sulphates from mixed solutions.—**Carl Hoepfner**, Frankfort-on-the-Main, Germany. Issued July 8, 1902.

A method of separating alkaline sulphates from mixed solutions, which consists in rapidly cooling the same by allowing them to flow into a cold solution of a suitable chloride, thereby preventing the formation of double salts.

- 546 704,641. Process of extracting zinc or other metals from their ores.—**Carl Hoepfner**, Frankfort-on-the-Main, Germany. Filed July 27, 1900. Issued July 15, 1902.

The process, which consists in reacting on a material containing an oxygen compound of metals insoluble in water and whose chlorides are soluble in a solution of alkali-metal chloride with sulphurous acid and an aqueous solution of alkali-metal chloride, whereby a solution is formed containing a chloride of a metal. Patented

also in England, Nos. 11,724 for 1894; 5,662 for 1895; 8,449 for 1895; 24,573 for 1896; 15,873 for 1900. German Patent, No. 155,065 for 1902.

- 547 707,506. Method of treating mixed sulphide ores.—**Erminio Ferraris**, Montepioni, Italy. Filed July 28, 1902. Issued August 19, 1902.

The process of decomposing mixed sulphide ores by means of concentrated sulphuric acid without the aid of extraneous heat. Patented also in England, No. 12,349 of 1901.

- 548 715,023. Process of treating zinc sulphide ores.—**John C. Clancy and Luke W. Marsland**, Sydney, New South Wales, Australia. Filed Feb. 16, 1901. Issued Dec. 2, 1902.

A process for the elimination of zinc and the recovery of lead, silver or other metals from sulphide ores consisting essentially in the following step by step operations: (a) roasting the pulverized ore with the addition of lead sulphate at such degree of heat as will not volatilize the lead contained in the ore or the added lead sulphate: (b) transferring the roasted ore while still very hot immediately from the roasting furnace into a vat containing a solution of sulphuric acid and water and thereby causing the solution to become heated to the boiling point, or thereabout: (c) agitating the whole mixture in the said vat during the process of charging, lixiviating, extracting, and dissolving of the zinc in the same: (d) recovering lead oxide by concentration from the ore and solution while undergoing treatment in the said solution: (e) converting the lead oxide so recovered into lead sulphate to be used for adding to succeeding charges of ore to be roasted in the furnace: (f) conducting the residual ore and solution into a settling vat and separating the solution from the ore by drawing off the zinc from the solution so separated and recovering from the said solution the sulphuric acid therein contained for use in treating succeeding charges of roasted ore; and (h) recovering the lead, silver and other metals contained in the residual ore by smelting the same in any suitable smelting-furnace. Patented also in England, No. 4,039 of 1901.

—Described in Jour. Soc. Chem. Ind., vol. 20, p. 481. May 31, 1901.

- 549 715,771. Treatment of zinc ores.—**Francis Ellershausen and Richard T. Western**, London, England. Filed August 4, 1902. Issued Dec. 16, 1902.

The process for the treatment of zinc ores and other zinciferous matter, consisting in acting on said ore or other matter with hydric ammoniac sulphate in solution to produce double sulphate of ammonia and zinc, agitating ammonium sulphate with slaked lime, drawing off the supernatant solution of ammonia, and treating the double sulphate of ammonia and zinc previously formed, with said ammonia solution to precipitate the hydroxide of zinc. 5 claims. Patented also in England, No. 26,166 of 1901; France, No. 24,062. Compare also U. S. Patent 700,311 (item 1006).

- 550 718,554. Method of extracting zinc.—**William G. Waring**, Tyrone, Pa. Filed June 14, 1902. Issued January 13, 1903.

The process consisting in leaching crude zinciferous ores, residues or products, by a leaching agent consisting of dilute acidulated water containing not more than 1.5 per cent. free sulphuric acid together with an indefinite amount of dissolved ferric sulphate; precipitating the metals of the copper group by agitation with a slight excess of a soluble sulphide and finally separating the zinc by means of hydrogen sulphide. 6 claims. Patented also in England, No. 28,925, of 1902.

- 551 733,000. Process of obtaining sulphide of zinc from copper slag.—**Ferdinand Brünjes**, Langelsheim, Germany. Filed August 11, 1902. Issued July 7, 1903.

A process of treating slags containing zinc oxides and sulphides of other metals capable of forming soluble chlorides, which consists in adding to the slag dilute hydrochloric acid to convert the sulphides into chlorides, liberate hydrogen sulphide and thereby precipitating zinc sulphide, separating the precipitate, and adding to the solution the sulphide of a metal of the alkaline earths to convert any zinc chloride into sulphide.

- 552 740,372. Process of extracting zinc from sulphide ores.—**Charles Rogers**, Kew, Victoria, Australia. Filed October 21, 1901. Issued September 23, 1903.

The process of extraction and recovery of zinc-containing sulphide ores or tailings, which consists in subjecting the same to a partial sulphatizing roast, discharging the same while hot into water, leaching the same with said water and with dilute sulphuric acid, subjecting the leached ores or tailings to a second sulphatizing roast, re-leaching the same with the lixivium from the former leaching and repeating said operations till sufficient zinc and sulphur are removed.

- 553 741,653. Process of treating lead, silver, or zinc ores.—**Solomon Ganelin**, Berlin. Filed Jan. 25, 1900. Issued October 20, 1903.

Consists in mixing said substances with a molten salt capable of dissolving the said oxides from the rest of the ore and then separating the metallic substances from said salt and the rest of the ore. Patented also in England, No. 24,469, of 1899.

- 554 751,712. Process of producing hydrated sulphide of zinc.—**Victor Bermont**, Paris, France. Filed May 6, 1902. Issued February 9, 1904.

A process for the preparation of pure zinc salts from the oxygen-bearing compounds, consisting in treating by ammonia the ore previously crushed and in separating by filtration, after decantation, the solution from the solid part; purifying the ammoniacal liquor produced consisting in precipitating the metals other than the zinc in the condition of insoluble sulphides formed when the soluble sulphide is gradually added to the first solution, in separating by filtration, after decantation, these precipitates from the liquid mass so as to obtain as precipitable salts only zinc salts, and in precipitating from this solution perfectly pure salts of zinc by the addition of soluble salt giving an insoluble salt of zinc. Patented also in England, No. 6,752, of 1902.

This process relates especially to the treatment of calamine and smithsonite.

- 555 754,643. Process of separating iron pyrites from zinc blende.—**Karl Danziger**, Zawodze, near Kattowitz. Filed May 29, 1903. Issued March 15, 1904.

A process for separating iron pyrite from zinc-blende, to the action of air moisture and heat and extracting the ferrous salt, which has been formed by the oxidizing action by water. Patented also in England, No. 5,016 of 1903.

- 556 781,133. Process of treating zinc sulphide ores containing iron.—**Chauncey E. Dewey**, Denver, Colorado., assignor to the American Zinc and Chemical Company, Denver, Colo. Filed April 2, 1904. Issued January 31, 1905.

The process for the treatment of zinc sulphide ores containing iron, consisting in first roasting the ore, whereby the zinc is converted into zinc sulphate and zinc oxide, and the iron present into ferric oxide, as far as practicable; second, placing the ore thus prepared in water; and third, maintaining the ore in suspension in the solution by the introduction of sulphurous gas whereby the zinc oxide present is formed into zinc sulphite, and the latter into zinc sulphate by reaction with the ferric oxide.

- 557 803,472. Extraction and purification of zinc.—**Alfred V. Cunningham**, Winnington, Eng. Filed July 20, 1904. Issued Oct. 31, 1905.

In the process of obtaining zinc from oxidized ores treating them with zinc chloride solution and hydrochloric acid with constant stirring, the solution being kept about neutral during the operation and separating the solution from the spent residue.

In the process of dissolving out zinc from its ores containing arsenic by means of a solution of a salt of zinc and the acid of said salt, neutralizing the solution by the addition of an alkali and then separating the arsenic by means of freshly precipitated ferric hydroxide. Patented also in England, No. 4,706 of 1904; in France, No. 350,580.

- 557a 805,577. Treatment of ores and the like.—**James Nicholas**, Waterloo, England. Filed May 27, 1905. Issued November 28, 1905.

The treatment of materials containing zinc, lead and precious metal, by mixing the pulverized materials with water, and with a chloride, then heating the mixture, leaching this so-treated mixture with water, reducing the metallic compounds contained in the leached residue to a metallic state, agitating the molten lead and precious metal with aluminium, cooling, then separating the alloy of precious metal with aluminum from the lead.

- 558 832,341. Process of treating complex sulphide ores.—**William G. Rumbold** and **George Patchin**, London. Filed Feb. 3, 1906. Issued October 2, 1906.

The process for the extraction of zinc and other metals from complex oxidized ores containing zinc, consisting in passing over successive lots of crushed ore a solution consisting of ferric sulphate, sulphuric acid, sodium chloride and water, until such solution becomes saturated with dissolved matter, such dissolved matter con-

sisting of the zinc and also the copper, cadmium, manganese, nickel, cobalt, antimony, lead, tin, or any or all of these metals when contained in said ores, a small proportion of ferric sulphate being employed in the solution in relation to a large amount of sulphuric acid whereby the ferric sulphate is continuously decomposed and regenerated until all the free acid has become neutralized. Patented also in England, no. 2,532 of 1905; in France, no. 363,025.

- 559 836,587. Wet method of extracting copper, zinc, etc., from their ores.—**Denis Lance**, Paris. Filed August 7, 1905. Issued November 20, 1906.

The process of extracting and concentrating metals from ores consisting in treating ores with nitrosulphuric acid and decomposable metallic chlorides, in causing nitrosulphuric acid to react upon decomposable metallic chlorides to form nitrochlorides, in causing the said nitrochlorides to react upon the metal contained in said ore to form the chloride of such metal, in causing the previously added nitrosulphuric acid to react upon the said metal chloride to form the sulphate of the metal contained in said ore. 16 claims.

- 560 850,965. Apparatus for producing alkali hydrates and zinc sulphide.—**Charles Ranson**, Brussels, Belgium, assignor to Henry William De Stuckle, Dieuze, Germany. Filed Sept. 6, 1905. Issued April 23, 1907.

An alkali apparatus comprising a closed receptacle adapted to contain alkali-forming reagents, heating means and agitating means for facilitating reaction therein, and means for feeding liquid reagent thereto controlled by the pressure of evolving gas in said receptacle. Patented also in France, no. 353,496.

- 561 863,411. Treatment of sulphide ores containing zinc.—**Ralph W. E. McIvor**, London, England, assignor to Metals Extraction Corporation, Ltd. London, England. Filed Feb. 2, 1906. Issued August 13, 1907.

The process of extracting zinc from sulphide ores containing the same, which consists in converting by heat the zinc contained in the ore into soluble sulphate of zinc and oxide of zinc, washing out the soluble sulphate with water, adding to the solution thus obtained calcium chloride, drawing off the solution of chloride of zinc so formed, adding the latter to the treated ore, digesting the whole to form an oxychloride of zinc, decomposing said oxychloride by an alkaline hydrate, and removing the precipitated zinc compound and washing the same. Patented also in England, No. 23,977 of 1905; in France, no. 362,677.

- 562 863,417. Process to utilize the inferior calamines.—**Francisco S. Moyano**, Aguilas, Spain. Filed Oct. 20, 1906. Issued Aug. 13, 1907.

A process of producing zinc oxide from ore containing carbonate of zinc, which consists in reducing said carbonate to oxide of zinc by calcination, heating the zinc oxide with chloride of calcium to produce zinc chloride, removing zinc chloride in solution from the remaining portions of the ore, transforming the zinc chloride into a carbonate of zinc by the action of the carbonate of magnesium, and finally transforming the resulting carbonate of zinc into oxide by the aid of heat.

- 563 875,424. Process for the treatment of zinciferous ores and metallurgical products.—**James H. Gillies**, Auburn, Victoria, Australia. Filed Aug. 20, 1906. Issued Dec. 31, 1907.

Consists of first roasting the ore to form a maximum amount of sulphate of zinc, and a minimum amount of sulphates of iron and copper, then feeding such roasted ore downwardly into a vessel in which there is an upwardly moving current of dilute sulphuric acid, withdrawing the gangue and undissolved mineral particles from the said vessels at the bottom, and withdrawing the solution of zinc sulphate and other soluble salts together with the slimes and certain mineral particles at the top, and finally subjecting the said solutions and the slimes and certain mineral particles to alternate settling and washing of the solids. Patented also in England, no. 1,004 or 1906.

- 564 875,425. Apparatus for leaching ores and the subsequent separation of the liquids from the solids.—**James H. Gillies**, Auburn, Victoria, Australia. Filed Aug. 20, 1906. Dec. 31, 1907.

The combination with a double walled vessel forming an annular space surrounding an internal space, the said walls being stepped or zigzag in vertical section and shaped as inverted cones at the bottom, of a discharge pipe from the bottom of said annular space and a discharge pipe from the bottom of the said internal space, and an inlet pipe for solution leading into the bottom of the annular space. Patented also in England, no. 994 of 1906.

- 565 875,866. Process of obtaining zinc oxide from zinc ores.—**Henry L. Sulman**, London, England. Filed Oct. 30, 1906. Issued Jan. 7, 1908.

The process of obtaining zinc oxide from zinc ores which consists in converting the zinc into oxide, treating the ore with sulphurous acid solution to dissolve the zinc as bisulphite, separating the bisulphite solution from the residue, adding to the solution zinc oxide which will remove sulphurous acid and precipitate the zinc as monosulphite, separating the zinc monosulphite from the liquor and drying and calcining the same to produce zinc oxide, and collecting the sulphurous acid evolved for repeated use. 9 claims.

- 566 880,775. Treatment of complex sulphide ores.—**Guy De Bechi**, London, England, assignor of one-half to Reginald Wynn Rucker, London, England. Filed April 9, 1907. Issued March 3, 1908.

A cyclical process for treating complex sulphide ores containing lead and zinc consisting in grinding or pulverizing the ore to the condition of an impalpable powder, treating the same with a solution of ferric sulphate, filtering the solution of ferrous sulphate and zinc sulphate so formed from the insoluble lead residue, converting the ferrous sulphate to ferric sulphate by oxidation and subjecting them to acid fumes evolved from the calcination of the zinc sulphate obtained from a previous operation, crystallizing out the zinc sulphate and separating the same from the ferric sulphate solution, calcining the zinc sulphate, subjecting the zinc and lead compounds separately to the usual metallurgical treatment and using the regenerated ferric solution for the treatment of a further quantity of ore. Patented also in England, no. 9,339 of 1906.

- 567 900,088. Treating oxide of zinc.—**Frederic P. Dewey**, Washington, D. C. Filed June 8, 1898. Issued Oct. 6, 1908.

The process of dissolving oxide of zinc, which consists in adding it in small portions at a time to water containing sulphurous acid, so that the free sulphurous acid remains always in excess.

- 568 914,730. Process of treating complex sulphide ores.—**George E. Kingsley**, Toronto, Can., assignor to A. E. Kingsley, Denver, Colo. Filed Dec. 23, 1907. Issued March 9, 1909.

In the treatment of complex ores, such as ores containing galena, zinc and antimony, immersing the ores in a dilute solution of nitric acid of a strength six and one-quarter to seven and one-quarter per cent, and heated to one hundred and seventy degrees Fahr.

- 569 918,749. Apparatus for use in solution and precipitation process.—**Woldemar Hommel**, London, England, assignor to Metals Extraction Corporation, Ltd. Filed November 30, 1908. Issued April 20, 1909.

- 570 925,190. Treatment of refractory zinc-lead ores.—**Percy C. C. Isherwood**, Harrow, England. Filed July 8, 1907. Issued June 15, 1909.

A process for extracting zinc and copper from refractory zinc lead ores consisting in washing the ore, treating it in a concentrated solution of ammonium sulphate and then heating the residues with solid ammonium sulphate at a temperature below redness. 8 claims. Patented also in England, no. 16,364 of 1906.

- 571 938,055. Method of treating poor sulphide ores.—**Alfred Holdsworth**, Barnsbury, London, England. Filed Nov. 1, 1907. Issued October 26, 1909.

The process for treating sulphide ore containing silver, zinc, copper, iron, etc., which consists in mixing with the finely divided ore material, an amount of sulphuric acid of substantially 60° Baumé determined by the composition of the material, and substantially in the proportion of one molecule of acid to each atom of sulphur present in the ore, calcining the mixture with free access of air to decompose the unstable sulphates into oxides and oxidize the sulphur, leaching out the soluble sulphates with water, subsequently leaching out certain of the oxides with sulphuric acid sufficiently weak not to attack other oxides present, and collecting the sulphur oxides for the production of sulphuric acid.

- 572 966,209. Obtaining zinc oxide from zinc ores and products.—**Woldemar Hommel** and **Henry Livingstone Sulman**, London, England, assignors to The Metals Extraction Corporation, Ltd., London. Filed Nov. 9, 1907. Issued August 2, 1910.

Consists in roasting the ore out of contact with the fuel, volatilizing from the roasted ore the zinc contents in the form of dry oxide, together with the other metallic matters, collecting the dry product thus volatilized, treating it with a solution of sulphurous acid

so as to obtain a solution of bisulphite of zinc, precipitating the zinc as insoluble monosulphite and calcining the monosulphite to produce zinc oxide. 10 claims.

- 573 966,389. Wet process for the treatment of ores.—**Henry Thomas Durant, Henry Livingstone Sulman, and Wolde-mar Hommel**, London, England. Filed November 11, 1909. Issued August 2, 1910.

The method of extracting zinc from its ores which consists in commingling the ore with a suspending liquid in forcing said ore and liquid through a conduit of restricted capacity and against maintained pressure by a jet of sulphurous acid whereby all portions of the ore are subjected to a uniform chemical action and in subsequently filtering the solution and precipitating the zinc. See also item 468.

- 574 999,420. Process of separating zinc or zinc oxide.—**George Wannschaff and Josef Savelsberg**, Papenburg, Germany. Filed Mar. 23, 1911. Issued August 1, 1911.

The method of separating zinc or zinc oxide from material containing the same, which comprises leaching the material with a heated aqueous solution of zinc chloride, cooling the solution to obtain a precipitate containing zinc oxide and zinc chloride, leaching the precipitate with water to remove the greater part of the zinc chloride, treating the residue with lime to convert all of the zinc salts therein into zinc oxide. Patented also in England, no. 5,577 of 1911; in France, no. 426,897.

- 575 1,009,750. Extraction of metals from their ores.—**Wolde-mar Hommel and Henry Durant**, London, England, assignors to The Metals Extraction Corporation, Ltd., London. Filed June 25, 1910. Issued Nov. 28, 1911.

The cyclic process for the extraction of zinc from its sulphide ores in which the only reagents employed are water and those supplied by the ore itself, which consists in roasting the ore to drive off gases containing sulphurous acid, cooling said gases and bringing them in contact with a mixture of the roasted ore and water to effect the solution of the zinc as sulphite and thereafter submitting said sulphite solution to the action of the hot gases from the ore roasting furnace whereby insoluble zinc monosulphite is precipitated, the said hot gases being enriched in sulphurous acid and cooled ready for the further treatment of the mixture of roasted ore and water. Patented also in France, no. 417,208 of 1910.

—Described in Met. & Chem. Eng., vol. 10, p. 179. Mar., 1912.

- 576 1,011,962. Treatment of refractory zinc-lead ores.—**Percy C. C. Isherwood**, Leytonstone, England. Filed April 8, 1910. Issued December 19, 1911.

A process of treating refractory zinc lead ores consisting in roasting the ores and leaching them with a solution containing less than the theoretical amount of the sulphuric acid necessary for complete solution of the zinc oxide contained in the ore when under ordinary conditions of temperature and pressure, at a high tempera-

ture and pressure of from 50 to 200 lbs. per square inch. 11 claims. Patented also in England, no. 21,584 of 1909; in France, no. 420,510; in Germany, no. 238,890. See also items 507 and 586.

—Described. *Met. & Chem. Eng.*, vol. 10. p. 179. Mar. 1912.

- 577 1,013,511. Process of producing pure zinc sulphide and thiosulphates.—**Pierre Pipereaut** and **Antony Vila**, Paris, France. Filed September 15, 1908. Issued January 2, 1912.

The process for treating zinc sulphide ore to recover zinc sulphide in a granular form, which consists in lixiviating the ore with caustic alkali solution, thereby forming alkali zincate, heating to boiling, adding sufficient free sulphur to precipitate the metals other than zinc in the form of sulphides, and separating the same from the solution prior to the precipitation of the zinc sulphide, and then adding, in small amounts, sufficient free sulphur to precipitate the zinc present, while keeping the liquid hot.

- 578 1,029,932. Process of treating zinc-bearing ore.—**James O. Johnstone**, Buffalo, New York. Filed July 20, 1911. Issued June 18, 1912.

The process of treating ores containing zinc and barites which consists in heating the ore in the presence of a reducing agent which converts the barium sulphate to barium sulphide, and subsequently leaching the mixture whereby the barium sulphide will go into solution and leave insoluble zinc sulphide. 9 claims.

- 579 1,041,060. Process for the treatment of refractory zinc-lead ores.—**Andrew Gordon French**, Nelson, British Columbia, Canada. Filed September 30, 1911. Issued October 15, 1912.

The process of separating zinc and manganese from complex ores which consists in first roasting the ore to drive off the excess of sulphur, then adding to the mass crushed bisulphate of sodium in the proportion from 5 to 15 per cent of bisulphate of sodium to the original weight of the ore before it has been calcined, then applying heat to the mixture to bring the mass to a dull red heat at a temperature below the sinter forming point, and subsequently recovering the soluble sulphates formed by the reaction, by lixiviation. 6 claims. Patented also in England, no. 22,077 of 1912.

—Described in *Met. & Chem. Eng.*, vol. 10, pp. 816-17. Dec., 1912.

- 579a 1,043,939. Filtering apparatus.—**Percy Claude Cameron Isherwood**, Leytonstone, England, assignor to Refractory Zinc Ore Treatment Company, a Corporation of N. Y. Filed Feb. 18, 1910. Issued Nov. 12, 1912.

- 580 1,063,356. Manufacture of sulphide of zinc.—**Joseph Koetschet** and **Joannes Claude Antoine Meyer**, Lyons, France. Filed Dec. 1, 1908. Issued June 3, 1913.

A process for the manufacture of sulphide of zinc, comprising subjection of a solution of crude zinc sulphate to preliminary treat-

ment with sulphurated hydrogen with the object of precipitating impurities, filtration of the liquid, and subjection of the same as a concentrated solution to intimate and prolonged contact with sulphureted hydrogen to precipitate zinc sulphide.

- 581 1,066,245. Production of zinc sulphate.—**Anson G. Betts**, Troy, N. Y. Filed Dec. 9, 1912. Issued July 1, 1913.

In extracting zinc from material containing zinc in the form of oxide, the treatment of said material with sulphuric acid in the presence of an oxidizing agent stronger in its oxidizing action than ferric sulphate. See also items 493 and 516.

- 582 1,069,178. Process of recovering zinc.—**Charles J. Reed**, Philadelphia, Pa. Filed June 3, 1912. Issued August 5, 1913.

Consists in treating material containing zinc with an excess of sulphuric acid, treating the resulting solution with an oxidizing agent, purifying the oxidized solution with an excess of zinc-containing substance, further purifying the solution and recovering the zinc from the purified solution.

- 583 1,071,856. Treatment of metal-bearing solutions.—**Edgar Arthur Ashcroft**, Balestrand, Norway. Filed April 25, 1912. Issued September 2, 1913.

The process for the treatment of metal bearing solutions to obtain the zinc therefrom which consists in adding to the solution a cyanogen compound and subsequently heating the mixture, whereby the zinc is obtained in the form of an insoluble compound. 9 claims.

- 583a 1,074,203. Deposition of metallic salts from solutions containing them.—**Harry Rees**, Llansamlet, Glamorgan, Wales, and **Henry Livingstone Sulman**, London, assignors to the Metals Extraction Corporation, Ltd., London. Filed August 18, 1911. Issued Sept. 30, 1913.

A process for depositing monosulphite and sulphate of a metal from a solution containing bisulphite and sulphate of the metal, which consists in subjecting a continuously moving thin film of the solution to the action of hot gases from a coke fire. 8 claims.

- 584 1,082,766. Collector.—**Morely Punshon Reynolds**, Cleveland, Ohio, assignor to W. S. Tyler Company. Filed September 16, 1912. Issued December 30, 1913.

- 585 1,082,797. Means for the maintenance of gas in confinement.—**Sidney Elliott Bretherton**, Berkeley, Cal. Filed Oct. 9, 1912. Issued Dec. 30, 1913.

- 586 1,089,412. Treatment of refractory zinc-lead ores.—**Percy Claude Cameron Isherwood**, Bushey Heath, England. Filed Oct. 18, 1912. Issued March 10, 1914.

A process for the recovery of zinc from prepared refractory zinc lead ore, consisting in roasting the ore, then leaching the ore under basic conditions with a quantity of fresh sulphuric acid less

than that which is necessary for the complete solution of the zinc contained therein and producing a highly basic solution of zinc, afterward leaching the ore with the remainder of the fresh sulphuric acid necessary for the complete solution of the zinc under conditions of high temperature and pressure, and adding the solution of zinc thus produced in the second leaching of the ore to the fresh sulphuric acid used in the first leaching of a fresh quantity of ore. Patented also in England, no. 22,855 of 1912. See also item 507.

- 587 1,091,269. Separation of metals from zinc-bearing ores or compounds.—**Edgar Arthur Ashcroft**, Balestrand, Sogn, Norway. Filed Apr. 25, 1912. Issued March 24, 1914.

The process for obtaining metals from solutions containing them which consists in precipitating the metals as hydrates with ammonia adding excess of ammonia to dissolve the zinc, lead, manganese and other hydrates present soluble in excess, separating the precipitated hydrates from the solution, precipitating the manganese by a slow stream of chlorine and separating it from the remaining solution, precipitating the zinc hydrate by adding to the solution a further quantity of purified zinc chloride, mixing with the precipitated zinc hydrate the ammonium chloride separated from the solution by crystallization, thereafter distilling the mixture firstly at a low temperature to drive off the water, secondly at about 300° C. to convert the zinc to fused zinc chloride, and to drive off the ammonia, recovering the ammonia, and thirdly raising the temperature to about 500° C. to drive off the excess of ammonium chloride. Patented also in England, no. 19,257 of 1911; in France, no. 446,755.

- 588 1,110,790. Apparatus for making and filtering solutions, applicable in the extraction of metals from ores and for like purposes.—**Percy C. Isherwood**, Bushey Heath, England. Filed June 26, 1914. Issued September 15, 1914.

- 589 1,118,894. Process of producing pure zinc oxide.—**Henry William De Stuckle**, Paris. Filed Feb. 18, 1914. Issued November 24, 1914.

A cyclical process of producing pure zinc oxide, which consists in reacting upon a dissolved zinc salt with ammonium sulphite in presence of caustic ammonia or ammonium carbonate, calcining the precipitated zinc sulphite and utilizing the evolved sulphur dioxide for regenerating the ammonium sulphite. Patented also in England, no. 28,188 of 1913; in France, no. 465,816.

- 590 1,120,683. Treatment of zinc-lyes.—**Wilhelm Buddeus**, Charlottenburg, Germany. Filed Nov. 26, 1913. Issued December 15, 1914.

The treatment of zinciferous lyes containing ferrous iron, consisting in adding to the lye a base in sufficient quantity to precipitate all the zinc and all the ferrous iron, drying the filtered and washed precipitate, thereby causing complete oxidation of the ferrous iron into the ferric state, and treating the dried mass with an acid to dissolve out the zinc. Patented also in England, no. 25,967 of 1913.

- 591 1,129,904. Removal of cadmium from zinc ores.—**Gilbert Rigg**, Palmerton, Pa., assignor to The New Jersey Zinc

Company, New York. Filed Dec. 3, 1914. Issued March 2, 1915.

The method of removing cadmium from zinc ores, which consists in first roasting the ore and lixiviating with water in the presence of zinc sulphate in amount sufficient to convert the cadmium to be removed into soluble cadmium sulphate, the zinc sulphate present being derived in part from the roasted ore, and in part from the addition of sulphuric acid to the lixiviating water, and drawing off the resulting solution from the ore.

- 592** 1,135,981. Process of making pure zinc oxide and recovering substances from waste and like liquors.—**Waldemar Asef**, Philadelphia, Pa. Filed July 19, 1913. Issued April 20, 1915.

The process of recovering pure zinc oxide from a zincate solution which consists in decomposing the solution by the addition of a solution of a salt or salts, thereby precipitating pure zinc oxide and forming a caustic alkali solution in which said salt or salts are inert, recovering the pure zinc oxide and evaporating the mother liquor to recover the caustic and the salt or salts. 8 claims.

- 593** 1,137,874. Process of leaching ores.—**Jasper A. McCaskell**, Salt Lake City, Utah. Filed June 2, 1914. Issued May 4, 1915.

The process of leaching ores and then regenerating the solvent, said process consisting essentially in producing chlorine gas electrolytically from metallic sodium chlorides, using the chlorine thus produced to chlorinate the metals in the ore that is being treated, and subsequently electrolyzing an aqueous solution of the chlorides in the cathode side of an electrolytic cell, thereby regenerating the original sodium chloride, the metals in the solution being deposited on the cathode of said cell. 5 claims.

- 593a** 1,144,480. Process for treating complex sulphide ores.—**George E. Kingsley**, Spokane, Wash. Filed Jan. 22, 1915. Issued June 29, 1915.

In the treatment of complex sulphide ores, the process of immersing the ores in a dilute solution of nitric acid of a strength of five per cent. or less, and heated to one hundred and seventy-six degrees F., whereby a nitrate is produced and sulphur in its natural state.

- 593b** 1,144,481. Process of treating mixed sulphide ores.—**Erich Langguth**, Neerpelt, Belgium. Filed Sept. 11, 1913. Issued June 29, 1915.

The process of treating sulphide ores which consists in treating said ores with molten zinc chloride, adding to the melt a limited quantity of zinc approximately that required to reduce the silver and only a part of the lead, then pouring the resultant molten mass into water whereby the remaining lead constituents of the ore become dissolved, then separating the dissolved constituents from the undissolved residue, and then extracting the lead from the solution. 6 claims.

- 594 1,154,602. Hydrometallurgy of zinc.—**Otto Best**, San Francisco, Cal. Filed March 26, 1913. Issued September 28, 1915.

In the recovery of zinc from ores and other materials containing the same in an acid-soluble form, the method of obtaining a solution which comprises extracting the zinc with sulphuric acid and treating the resulting solution before separation from the undissolved material with lime in amount insufficient to precipitate the zinc. 32 claims.

- 595 1,157,153. Process for the industrial separation of lead and zinc contained in the state of sulphides in ores.—**Guy De Bechi**, London. Filed Mar. 29, 1913. Issued October 19, 1915.

A process for the industrial separation of lead and zinc contained in the state of sulphides in ores consisting in reducing the ore to an impalpable powder, treating said powder by a mixture of ferric sulphate, ferric acid and nitric acid, whereby sulphides are transformed into sulphates with formation of free sulphur, and separating the zinc solution from the lead sulphate by filtration. Patented also in England, no. 4,246 of 1913; in France, no. 454,255.

- 596 1,173,467. Process of treating zinc ores.—**C. C. Titus** and **W. J. Barendscheer**, Helena, Mont., assignors to New England Electro-Chemical Metals Company, Boston. Issued Feb. 29, 1916.

The dry ore is chloridized in the presence of sodium chloride, the soluble chlorides extracted, and the metal contents of the solution precipitated, with ultimate replacement of their chlorides by sodium chloride. The resulting sodium chloride solution is electrolyzed, the evolved chlorine being used to chloridize fresh ore, and the chlorinated anode-liquor to extract the chloridized mass.

—Described in Jour. Soc. Chem. Ind., vol. 35, pp. 475-76, April 29, 1916.

- 597 1,177,396. Desulphurizing method for treating refractory ores.—**Edward Hale Dickie**, Goldroad, Ariz. Filed Jan. 25, 1915. Issued March 28, 1916.

The method of treating refractory ores consisting in mixing the finely ground ore with a solution of caustic soda and potassium acetate agitating the mixture in the presence of a metallic value precipitant, and finally removing the solution.

- 598 1,190,765. Extraction of zinc from its ores or products.—**Henry Thomas Durant**, London, England, assignor to The Metals Extraction Corporation, Ltd. London. Filed May 4, 1914. Issued April 25, 1916.

Consists in roasting the ore so as to produce mainly sulphate of zinc, passing the furnace gases through circuit solution containing metallic sulphates but fairly free from sulphites so as to produce a solution of sulphur dioxide, and leaching the ore with the said solution of sulphur dioxide whereby the first runnings from the leached ore are rich in sulphates, while the solution subsequently obtained by the action of the solvent liquor on the ore contains metallic

sulphites. 11 claims. Patented also in England, nos. 21,581 and 22,761 of 1913.

- 599 1,182,320. Method of treating flue products.—**Francis C. Ryan**, Hammond, Ind., assignor of one half to The United States Metals Refining Company, Chrome, N. J. Filed Feb. 24, 1914. Issued May 9, 1916.

The process of treating oxidized mineral bearing material, comprising roasting the material with a sufficient amount of strong sulphuric acid to insure an acid condition of the roasted material, adding water to the roasted material and boiling under an acid condition, filtering, reducing the acidity of the solution to a slightly acid condition to precipitate impurities and separating the solution for a subsequent treatment for zinc.

- 600 1,184,585. Process of treating ores.—**Edward Snyder**, Pioche, Nev. Filed Mar. 31, 1915. Issued May 23, 1916.

A process of treating oxidized ores containing lead, zinc and other metals, which comprises leaching the oxidized ore with a hot liquid containing an alkali sulphate, and containing sulphuric acid in amount sufficient to dissolve a part only of the zinc contained in said ore, separating the resulting liquid from the ore, and rendering the same slightly alkaline to precipitate zinc hydroxide, treating the digested ore with a strong solution of caustic alkali to extract a further amount of zinc from the ore, and adding to the liquor thereby produced an acid in amount at least nearly equivalent to the alkali present in said solution, to precipitate lead therefrom. 8 claims.

—Described. Jour. Soc. Chem. Ind. vol. 35. p. 744. July 15, 1916.

- 601 1,185,757. Process of preparing pure zinc sulphate solution from zinc ores.—**Shunjiro Araki**, Osaka, Japan. Filed Sept. 6, 1913. Issued June 6, 1916.

The process of producing a pure zinc sulphate solution from zinc ores which comprises extracting the ores with a sodium bisulphate solution, removing from the solution the heavier metals by treatment with metallic zinc, separating the greater part of the iron and manganese by neutralizing with alkali and by treatment with an oxidizing agent, and removing the remainder of the iron and manganese by adding sodium silicate neutralizing the sodium silicate with sulphuric acid to form silicic acid and sodium sulphate and heating the resulting solution containing silicic acid to convert the dissolved colloidal silicic acid into an insoluble form. Patented also in England, no. 15,546 of 1913; in France, no. 464,038; in Germany, no. 273,609. See also item 496.

- 602 1,185,902. Process of treating ores.—**Royal S. Handy**, Kellogg, Idaho. Filed October 28, 1914. Issued June 6, 1916.

The process of treating sulphide ores containing lead, silver and zinc which comprises roasting the ore, extracting the lead sulphate with an aqueous solution of sodium chloride then extracting the silver and zinc with an aqueous solution of ferric chloride, and recovering the metal values from the resulting solutions.

- 603 1,198,241. Treatment of zinc solutions for the recovery of the metal therefrom.—**Robert Lance**, Paris, France. Filed June 24, 1914. Issued September 12, 1916.

The process of treating solutions containing sulphate of zinc, consisting in maintaining the zinc solutions saturated with sulphurous acid while adding gradually to the zinc solution during the treatment with sulphurous acid, earthy alkaline oxide whereby the zinc sulphite formed is maintained in solution. Patented also in France, no. 463,614.

—Described in Jour. Soc. Chem. Ind. vol. 35, p. 1068. Oct. 31, 1916.

- 604 1,201,586. Process for the production of zinc oxide.—**Edouard Hunebelle**, Paris, France. Filed May 23, 1914. Issued Oct. 17, 1916.

The method of obtaining pure zinc compounds from zinciferous materials, which consists in treating the zinciferous material with hydrochloric acid and then adding magnesium sulphate and calcium carbonate to precipitate impurities and leave substantially pure zinc chloride.

- 605 1,204,843. Process of extracting metals from their ores.—**S. E. Bretherton** and **F. L. Wilson**, Berkeley, Cal. Issued Nov. 14, 1916.

To extract zinc from zinc sulphide ores, the ore is pulverized, roasted to convert the zinc into basic sulphate, treated under pressure with a solution containing ammonia and carbon dioxide to dissolve the zinc, and the solution separated and heated to precipitate the zinc as a basic carbonate.

- 606 1,261,694. Method of treating sulphide ores.—**Frank K. Cameron** and **John A. Cullen**, Salt Lake City, Utah, and **Reed W. Hyde**, New York, N. Y., assignors to American Smelting and Refining Company, Salt Lake City. Filed June 18, 1917. Issued April 2, 1918.

The method of recovering elemental sulphur and metal values from sulphide ores, which consists in quickly heating sulphide ore and strong sulphuric acid to a reacting temperature approximating the boiling point of the acid, distilling off sulphur, and recovering the metal values from the residue.

- 607 1,261,695. Production of zinc chloride.—**Frank K. Cameron** and **John A. Cullen**, Salt Lake City, Utah, and **Reed W. Hyde**, New York, N. Y., assignors to American Smelting & Refining Company, Salt Lake City. Filed June 18, 1917. Issued April 2, 1918.

Method of preparing zinc chloride from oxide ores of zinc, which consists in reacting thereon with strong solution of hydrochloric acid in proportions sufficient to combine with the bases present, desiccating the mass by heat and maintaining the same at about 300° C. until substantial evolution of hydrochloric acid ceases and then dissolving the zinc chloride from the mass.

—Described in Met. & Chem. Eng. vol. 18, p. 550. May 15, 1918.

- 608** 1,261,696. Producing zinc chloride from ores.—**Frank K. Cameron** and **John A. Cullen**, Salt Lake City, Utah, and **Reed W. Hyde**, New York, N. Y., assignors to American Smelting & Refining Company, Salt Lake City. Filed July 17, 1917. Issued April 2, 1918.

Method of producing zinc chloride from oxidized zinc ores also containing lead, which consists in mixing the ore with a metal chloride, distilling lead chloride from the mixture, and recovering the zinc chloride from the distillation residue by leaching.

- 608a** 1,281,031. Process of recovering zinc.—**Frederick Laist**, Anaconda, Mont., assignor to Anaconda Copper Mining Company. Filed Jan. 29, 1918. Issued October 8, 1918.

In a process of recovering zinc from silicious calcine, the steps which consist in leaching the calcine with an acid liquor, neutralizing the liquor and thereby precipitating silica in presence of the insoluble residue, separating the zinc bearing solution from the residue, dehydrating the residue, recovering zinc values therefrom by leaching with an acid solution and returning the resulting zinc bearing solution to the primary leaching operation.

- 608b** 1,295,080. Extraction of zinc.—**Henry Livingstone Sulman** and **Hugh F. Kirkpatrick-Picard**, London, England, assignors to The Metals Extraction Corporation, Ltd. Filed Jan. 20, 1917. Issued Feb. 18, 1919.

In a process for the extraction of zinc from zinc-containing material treating the material with acid to dissolve the zinc, filtering the clear solutions from the residue, washing the residue to remove the solution remaining therein, adding milk of lime to the said washings to precipitate zinc hydrate and adding the precipitate so obtained to the solution produced from a fresh batch of zinc-containing material by treatment with acid to complete quickly the neutralization of the acid.

Part of a process preparatory to electrolysis.

Great Britain

- 609** 1,374 of 1891. Treating ores and residues containing zinc by means of bisulphate of soda for the production of commercial products—**A. M. Clark**, London.

- 610** 4,916 of 1894. Treating zinc and iron chloride.—**E. Warzee**, Brussels.

Separating zinc and iron chlorides by adding sufficient metallic zinc to the solution to throw down all the iron as oxide.

- 611** 13,850 of 1894. Improved process of treating refractory ores and apparatus to be used therein. **E. A. Ashcroft**, Broken Hill, N. S. W.

The ore is given an oxidizing roast, leached by the ferric chloride or ferric sulphate method, according to relative zinc-lead content, and electrolyzed with insoluble anodes. Many modifications of the process are described in the patent claims.

- 612 22,826 and 22,827 of 1894. Improvements in the treatment of zinc chloride for the purification thereof for electrolytic processes.—**J. Brock, A. E. Wareing and F. Hurter**, Liverpool.

Removing oxides and sulphides of zinc and other impurities from zinc chloride solution before electrolysis.

- 613 7,560 of 1895. Leaching zinc.—**Carl Hoepfner**, Giessen, Germany.

In the process of producing chloride of zinc from sulphide, mixing nitric acid with the acid and the ore, so as to prevent the oxidation of the sulphide.

- 614 8,328 of 1895. Treating zinc-lead sulphides.—**C. Hoepfner**, Giessen, Germany.

Treating zinc lead sulphides with chlorine or chlorides of iron or copper, so dissolving out the lead and leaving the zinc.

—Described in *Zeits. f. Elektrochem.*, vol. 3, p. 109, Sept. 5, 1896.

- 615 8,449 of 1895. Making zinc chloride.—**C. Hoepfner**, Giessen, Germany.

Making zinc chloride by treating zinc oxide with sulphurous acid, oxidizing to sulphate and treating with an alkaline chloride.

- 616 8,328 of 1896. Improvements in the treatment of ores or materials containing zinc, lead, and silver.—**C. Hoepfner**, Giessen, Germany.

Treated with a chloride solution to remove lead and silver. The residue containing zinc may be treated for its recovery in any known way.

- 617 10,494 of 1896. Recovery of zinc.—**J. R. Wylde, J. W. Kynaston and J. Brock**, Liverpool.

Method of recovering zinc from the spent liquors or copper leaching.

- 618 16,312 of 1896. Treatment of solutions of ores containing zinc for the recovery of zinc as oxide.—**E. A. Ashcroft**, New Castle, N. S. W.

"Zinc sulphate is converted into a paste by stirring in zinc oxide, which is strongly heated so as to drive off sulphuric or sulphurous acid gases. In some cases the pasty mass is mixed with carbon before heating."—**J. S. C. I.**

- 619 17,299 of 1896. Improved process for the treatment of zinciferous sulphide ores.—**E. F. Turner**, Adelaide, Australia.

The crushed ore is roasted to oxide in the presence of a current of superheated steam. The zinc and lead oxides are converted into sulphites.

—Described in *Jour. Soc. Chem. Ind.*, vol. 16, p. 683, Aug. 31, 1897.

- 620 20,615 of 1896. Treatment of zinc and copper ores.—**W. J. Koehler**, Broken Hill, N. S. W.

Zinc and copper being present as oxides, the ore is leached with ammonium sulphate and heated to 300°-500° C.

- 621 9,409 of 1897. Reducing zinc-lead sulphides.—**H. R. Angel**, London.

Improvements in the process for reducing zinc-lead sulphides by sulphate of soda.

- 622 16,808 of 1897. Treatment of complex sulphide ores and apparatus therefor.—**F. Ellershausen**, London.

—Described in Jour, Soc. Chem. Ind., vol. 16, p. 1021, Dec. 31, 1897.

- 623 285 of 1898. Improvements in the treatment of ores containing intimately mixed copper, lead and zinc.—**Guy de Bechi**, Paris.

"The crushed ores are given a chlorinating roasting, followed by practical precipitation of the copper and zinc as hydrated oxides."

- 624 11,940 of 1898. Improved method of treating flue dust obtained from sulphide ores.—**R. Threlfall**, Preston.

"The flue dust and fume are treated with a solution of potassium or sodium hydrogen sulphate, such as nitre-cake, by which the zinc is dissolved and separated from the lead."

- 625 22,366 of 1898. Production of zinc oxide and carbonate from ores or other materials containing zinc.—**G. Rigg**, Swansea.

"The material is leached with a solution of ammonium carbonate or a mixture of this with ammonium hydrate. The zinc-dissolving capacity of the solution varies with the amount of carbonic acid present. The zinc is precipitated by means of carbonic acid gas."—**J. S. C. I.**

- 626 2,712 of 1899. Treatment of refractory sulphide ores.—**W. R. Hutton**, Glasgow.

"The ores are heated with nitrate of soda, which may be added as a dry salt to the ore in the furnace, or as a concentrated solution to the ore previously. The metals are converted into their sulphates, and the fumes are forced into water, the zinc sulphate dissolving and the lead sulphate remaining insoluble,"—**J. S. C. I.**

- 627 3,575 of 1899. Sulphide ore treatment.—**Chemische-Fabrik Rhenania**, Aix-La-Chapelle, Germany.

Treating mixed sulphide ores ground fine with concentrated sulphuric acid under heat, so forming sulphates of lead and zinc separable by lixiviation.

- 628 10,850 of 1899. Extraction of zinc from substances or compounds containing the same.—**T. Ryan, jr.** and **N. Hughes**, Flint.

Zinc fume, flue dust, calcined blende, waste scrap or like material is treated with solution of caustic alkali; any lead is precipitated

with zinc and iron scrap; the zinc is precipitated as oxide by means of carbonic acid.

- 629** 21,871 of 1899. Obtaining zinc solutions free from iron and manganese compounds.—**F. A. Gasch**, Hoemmingen-am-Rhein, Germany.

"Zinciferous spent pyrites is treated with concentrated H_2SO_4 with or without the addition of sodium chloride, or with strong HCl and FeCl_2 , and after remaining in heaps for a time, the mass is roasted at a low red heat. After withdrawal from the furnace, but while still nearly red hot, sodium nitrate or other oxydizing agent and lime are added. The ferrous and manganese compounds are thus oxidized and remain undissolved on leaching, a zinc solution being obtained."—J. S. C. I.

- 630** 253 of 1900. Improved process for separating lead from zinc, when both metals exist together in solution as nitrates, chlorides, or partly as nitrates and partly as chlorides.—**G. E. and A. R. Davis**, Manchester.

"Zinc oxide is added to the solution of mixed lead and zinc salts, and carbonic acid gas is passed through, whereby lead carbonate is precipitated, zinc replacing lead in the solution."—J. S. C. I.

- 631** 710 of 1900. Treatment of certain mixed sulphide ores for the recovery of their valuable constituents.—**G. E. and A. R. Davis**, Manchester.

"Treating mixed sulphides of lead and zinc by leaching with nitric acid and removing the lead by adding zinc oxide."—E. & M. J.

- 632** 985 of 1900. Treatment of complex zinc ores.—**Guy de Bechi**, Paris.

"Zinc-bearing sulphide ores are mixed and roasted with 15 to 30% of silica, silicious sand, or other silicious matter, whereby the zinc is rendered more completely soluble in acid than when the ore is roasted by itself, and consequently the residue, after leaching, is more suitable for further metallurgical treatment."—J. S. C. I.

- 633** 2,089 of 1900. Treatment of mixed sulphide ores containing lead and zinc.—**G. E. and A. R. Davis**, Manchester.

"Improvements in the patentees' process (253 and 710 of 1900) for treating mixed zinc-lead sulphides by lixiviation with hydrochloric acid and adding zinc oxide to precipitate the lead."—E. & M. J.

—Described in Jour. Soc. Chem. Ind., vol. 19, pp. 129-130, Feb. 28, 1901.

- 634** 11,108 of 1900. Zinc sulphide pigment.—**E. Beringer**, Berlin, Germany.

The production of zinc sulphide suitable as white pigment from an ammoniacal solution of zinc oxide.

- 635** 14,983 of 1900. Treatment of zinc-lead sulphide ores and tailings.—**T. Twynam**, London.

Treating with chloride of zinc and separating out the lead chloride.

—Described in Jour. Soc. Chem. Ind., vol. 20, p. 905, Sept. 30, 1901.

- 636 12,510 of 1901. Zinc sulphate making.—**Meister Lucius & Bruning**, Hoechst-am-Main, Germany.

Method of making a sparingly soluble zinc hydrosulphite by treating a sulphite with zinc dust and an acid.

- 637 21,097 of 1901. Extraction and recovery of zinc from sulphide ores or tailings.—**C. Rogers & A. M. Oswald**, Caulfield, Australia.

Calcium polysulphide is claimed for use in precipitating zinc sulphide from sulphate solutions.

- 638 16,272 of 1902. Treating zinc slags.—**F. Brunjes**, Langelsheim, A. M., Germany.

Treating copper slags containing zinc, barium, iron, etc., with HCl, the iron, barium, etc., being dissolved and the zinc recovered as sulphide.

- 639 9,360 of 1903. Making zinc hydrosulphite.—**C. Bolle**, Manchester.

An improved process for making zinc hydrosulphite difficultly soluble in water by acting on zinc dust with sulphurous acid and then adding sodium bisulphite.

- 640 23,843 of 1903. Leaching sulphide ores.—**J. B. de Alzugaray**, London.

Leaching sulphides by means of solutions of chlorides or alkali and other metals, with free hydrochloric acid.

- 641 13,121 of 1904. Recovery of zinc.—**J. Nicholas**, Liverpool.

"Removing zinc from mixed ores by roasting with salt and dissolving out the chloride of zinc, and afterward collecting silver and gold from the lead by means of aluminum."—E. & M. J.

- 642 15,577 of 1904. Leaching sulphide ores.—**J. Nicholas**, Liverpool.

"Treating complex ores with common salt, and then leaching out the zinc chloride, and afterward adding more salt, sulphuric acid and peroxide of manganese for the purpose of converting the remaining metals into chlorides."—E. & M. J.

- 643 22,235 of 1905. Leaching ores.—**H. Baker and A. T. Smith**, Runcorn, England.

"Treating finely ground sulphides of lead, zinc etc., with aqueous solutions of ferric chloride, thus forming chloride of the metal, ferrous chloride, and free sulphur."—E. & M. J.

- 644 24,238 of 1905. Method of treating complex sulphide ores containing copper, zinc and lead.—**N. M. Ogle**, London.

"The granular ore is roasted at a dull red heat so as to convert as much as possible of the zinc sulphide into sulphate: to this end, a small quantity of sodium nitrate may be added. The roasted ore is systematically extracted with boiling water, which dissolves out zinc sulphate. The impure zinc sulphate solution is freed from copper either by electrolysis or by adding metallic zinc, and from iron by oxidizing the solution by air or bleaching powder and adding zinc

oxide or carbonate, and is evaporated to dryness. . . . zinc oxide is formed," purified, briquetted and smelted for zinc.—J. S. C. I.
—Described in Jour. Soc. Chem. Ind. vol. 26, p. 21, Jan. 15, 1907.

- 645 16,912 of 1906. Leaching ores.—**R. W. E. MacIvor** and **M. Fradd**, London.

"Improvements in the method of dissolving zinc from roasted zinc-lead ores by means of calcium chloride or sulphurous acid, and subsequently precipitating by lime."—E. & M. J.

- 646 17,001 of 1906. Treatment of zinc.—**R. W. E. MacIvor** and **M. Fradd**, London.

Treating residues from zinc distilling furnaces by mixing with sulphuric acid into a stiff paste and heating to about 300° to 500° C., and then leaching out the sulphate of zinc so formed.

- 647 21,440 of 1906. Extracting zinc from residues.—**R. W. E. MacIvor** and **M. Fradd**, London.

"Extracting zinc from distillation residues by heating with calcium chloride and sulphuric acid and throwing down the oxide from the resulting zinc chloride solution by the addition of lime."—E. & M. J.

- 648 22,534 of 1906. Ore treatment.—**H. L. Sulman**, London.

"Improvement in the process described in 21,672 of 1906, whereby the zinc is precipitated as monosulphite by blowing air through the solution of bisulphite."—E. & M. J.

- 649 24,526 of 1906. Treatment of calamine.—**F. S. Mojano**, Aguilas, Spain.

"Process for utilizing low grade calamine by first calcining and then treating with a solution of calcium chloride, the zinc chloride thus produced being precipitated as oxide by the admixture of carbonate and magnesium."—E. & M. J.

- 650 26,934 of 1906. Treatment of sulphide ores.—**H. Baker**, Runcorn, England.

"Improvements in the inventor's process for treating sulphide ores with chlorides for the production of lead, copper or zinc chlorides with the object of preventing the undue precipitation of these metals from the solutions obtained."—E. & M. J.

- 651 4,471 of 1909. Method of recovering lead and zinc from compounds containing these metals.—**H. W. Hemenway**, Stratford, Essex.

Comprises treatment "with lead or zinc acetate or with acetic acid, so that the lead goes into solution as subacetate, while the zinc is precipitated."—J. S. C. I.

- 652 18,817 of 1909. Bisulphite process.—**W. Hommel** and **H. T. Durant**.

—Described in Min. Mag., vol. 4, p. 139, Feb., 1911.

- 653 17,587 of 1910. Method of extracting oxide of zinc from ores and tailings.—**F. C. Beauchamp**, London.

"The ore is first treated with sulphuric acid to dissolve the metals which are precipitated as hydroxides by means of lime. Treatment with sodium hydroxide or ammonia separates the zinc in solution. Addition of sulphuric acid or zinc sulphate solution re-precipitates the zinc as hydroxide, which is washed and heated to yield the oxide."

- 654 16,218 of 1912. Removal of zinc from the ore, particularly of zinc-lead ore.—**H. C. Woltereck** and **J. Moeller**, London. Issued July 11, 1912.

"Process of removing zinc from roasted ores by means of hot ferrous sulphate solution, zinc sulphate and ferrous hydroxide being formed."—**J. S. C. I.**

- 655 12,799 of 1915. Extraction of zinc.—**Metals Recovery Co., Ltd.** and **R. W. E. Mac Ivor**, London.

This process is applicable to lead-zinc sulphide ores containing iron. The ore is given a sulphating roast, mixed with a certain proportion of a previous charge containing ferric oxide. The roasted ore is then leached in sulphuric acid solution.

—Described in *Min. Mag.*, vol. 16, p. 55. Jan., 1917.

France

- 656 392,867. Treatment of acid metallic solutions for the extraction of zinc.—**P. D'Alton-Shee**. Oct. 8, 1907.

Applicable to separation of zinc from other metals in a solution "such as that obtained by the action of acid on roasted blends. The filtered solution is mixed with a small quantity of sodium hydrochlorite, in order to oxidize any iron, chromium or manganese, which are afterwards precipitated by the addition of zinc oxide or hydroxide to the hot solution. The zinc is finally precipitated by the addition of ammonia, not in excess."—**J. S. C. I.**

- 657 408,062, 408,092 and 408,093. Process, lixiviation apparatus, and reduction furnace for the treatment of zinc carbonate ores.—**G. Dantin**. Oct. 16, 1909.

The ore is treated with sulphurous acid at a temperature above 50°C., whereby the zinc carbonate is converted into sulphate, which is recovered by lixiviation.

—Described in *Jour. Soc. Chem. Ind.*, vol. 29, p. 637. May 31, 1910.

- 658 476,304. Process for treating ores of zinc, copper, cadmium, cobalt, nickel, etc.—**R. D. Lance**. Apr. 15, 1914.

The metals are converted into sulphates by heating the ore with sulphuric acid, the product is roasted at about 800° C. in presence of air and steam to decompose ferric sulphate, and the sulphates are removed by leaching and converted into chlorides by addition of calcium chloride. The metals are precipitated from the chloride solution as hydroxides by adding calcium sodium oxychloride, with regeneration of calcium chloride.

—Described in *Jour. Soc. Chem. Ind.*, vol. 35, p. 54. Jan. 15, 1916.

- 659 480,499. Production of zinc sulphate from zinciferous minerals.—**Erminio Ferraris**. Dec. 21, 1915.

The roasted or desulphurized ore is treated with sulphur dioxide, and the precipitated zinc sulphite is treated with moist air to convert it into sulphate, which is dissolved by lixiviation with pure or acidulated water.

Germany

- 660 86,153. Zinc leaching.—**C. Hoepfner**, 1895.
Process for transforming the zinc oxide formed by roasting calamine or blende into a carbonate, preliminary to converting the carbonate into chloride as in English Patent 11,724 of 1894.
- 661 142,933. Dezincing zinciferous roasted pyrites.—**August Gasch**, Munich. Sept. 21, 1899.
Leaching with concentrated sulphuric acid, and roasting.
—Described in Zeits. f. angewandte Chem., vol. 16, p. 684. July 14, 1903.
- 662 149,161. Process for eliminating pyritic iron from zinc blende.—**Alfred Kunze** and **Karl Danziger**, Zawodzie, Silesia, Germany. Feb. 22, 1903.
The ore is given an oxidizing roast, to make the pyrites soluble in water.
—Described in Zeits. f. angewandte Chem., vol. 17, p. 430. Apr. 1, 1904.
- 663 154,085. Process for eliminating the iron and manganese from zinc solutions.—**Lorenz Lucas**, Hagen, Germany. Nov. 1, 1903.
Treatment with lead peroxide.
—Described in Zeits. f. angewandte Chem., vol. 17, p. 1829. Nov. 25, 1904.
- 664 165,455. Process for working up zinciferous ores and smelter products.—**Zinkgewinnungs-Gesellschaft**, Berlin. Mar. 24, 1905.
Leaching with sulphuric acid and precipitation of the zinc as hydroxide, by means of sodium hydroxide. Modified by 169,138, below.
—Described in Zeits. f. angewandte Chem., vol. 19, p. 1619. Sept. 21, 1906.
—Described in Jour. Soc. Chem. Ind., vol. 25, p. 991. Oct. 31, 1906.
- 665 169,138. Process for the treatment of zinciferous ores and smelter products.—**Zinkgewinnungs-Gesellschaft**, Berlin. May 24, 1905.
Addition to 165,455, above. "Zinc and magnesium hydroxides are precipitated by quick-lime, and the zinc is dissolved out of the

precipitate by treatment with a solution of sodium hydroxide and sodium sulphate. The solution is used for leaching a fresh quantity of ore."

—Described in Jour. Soc. Chem. Ind., vol. 25, p. 991. Oct. 31, 1906.

- 666 170,460. Process for producing a pure zinc chloride solution from waste liquors containing organic impurities.—**T. Goldschmidt**, Essen, Germany. June 8, 1906.

The solution is heated to 300° or 400°.

- 667 173,209. Process for recovery of zinc from siliceous zinc ores by leaching with a concentrated neutral zinc salt solution.—**Alfred V. Cunningham**, Winnington, England. Jan. 28, 1904.

—Described in Zeits. f. angewandte Chem., vol. 20, p. 159. Jan. 25, 1907.

- 668 188,793. Process for the recovery of copper, zinc, cadmium, etc., from their carbonate or oxide ores in the form of hydroxides.—**Denis Lance**, Paris. Mar. 29, 1905.

—Described in Zeits. f. angewandte Chem., vol. 21, p. 166. Jan. 24, 1908.

- 669 197,044. Process for leaching zinc and other metals from oxidized or roasted ores by means of sulphuric acid and ferric sulphate.—**William G. Rumbold** and **George Patchin**, London. Feb. 7, 1906.

—Described in Zeits. f. angewandte Chem., vol. 21, pp. 1460-61. July 3, 1908.

- 670 200,613. Process for working up mixed sulphide ores with ferric sulphate, oxidizing the resulting ferrous sulphate, and using in the process the acid gas generated by the calcination of the zinc sulphate.—**Guido de Bechi** and **Reginald W. Ruecker**, London. Apr. 19, 1907.

—Described in Zeits. f. angewandte Chem., vol. 21, p. 1992. Sept. 18, 1908.

- 671 203,149. Process for dezincing zinc and iron bearing materials by heating with concentrated sulphuric acid and subsequent leaching.—**Zinkgewinnungs-Gesellschaft**, Berlin. Feb. 21, 1907.

—Described in Zeits. f. angewandte Chem., vol. 22, p. 268. Feb. 5, 1909.

—Described in Jour. Soc. Chem. Ind., vol. 27, p. 1158. Dec. 15, 1908.

- 672 203,628. Process for the manufacture of zinc oxide by the leaching of ores with sulphurous acid.—**Henry L. Sulman**, London. Oct. 21, 1906.
—Described in *Zeits. f. angewandte Chem.*, vol. 22, p. 270. Feb. 5, 1909.
- 673 209,508. Process for the extraction of copper, zinc and other metals, except gold, from roasted pyrite residues.—**Auguste Tixier**, Billancourt, France. Aug. 26, 1906.
Leaching with chlorine.
—Described in *Zeits. f. angewandte Chem.*, vol. 22, p. 1035. May 28, 1909.
- 674 218,226. Process for working up refractory lead ores by treatment with ammonium sulphate or ammonium chloride.—**P. C. C. Isherwood**, Wealdstone, England. July 19, 1907.
- 675 246,047. Process for working up siliceous zinc ores, by which the zinc is sulphatized without perceptibly sulphatizing the lead, and simultaneously a concentrated solution of zinc sulphate is obtained.—**Frank B. Dick**, Lyndhurst, England. July 11, 1911.
—Described in *Zeits. f. angewandte Chem.*, vol. 25, pp. 1257-58. June 14, 1912.
- 676 246,973. Treatment of mixed lead-zinc ores for the purpose of recovering lead and a pure zinc solution.—**Jean de Coppet**, Paris, France. Aug. 27, 1910.
—Described in *Zeits. f. angewandte Chem.*, vol. 25, p. 1258. June 14, 1912.
- 677 254,443. Treatment of materials containing zinc or zinc oxide with a zinc chloride solution.—**Georg Wannschaff** and **Josef Savelsberg**, Papenburg, Germany. Mar. 8, 1910.
—Described in *Zeits. f. angewandte Chem.*, vol. 26, pt. II, p. 55. Jan. 28, 1913.
- 678 257,647. Precipitation of metals, especially of zinc, copper or nickel, from sulphuric or sulphurous acid solutions by means of magnesium compounds, such as magnesium sulphite or bicarbonate.—**Stanislaw Laszczynsk**, Miedzianka, Russia. Nov. 20, 1910.
- 679 266,219. Process for the technical separation of lead and zinc which are present in ore as sulphides, by means of a ferric sulphate solution containing sulphuric and nitric acid.—**Guido de Bechi**, London. Mar. 12, 1913.
—Described in *Zeits. f. angewandte Chem.*, vol. 26, pt. II, p. 687. Nov. 18, 1913.

- 680 271,135. Production of metallic zinc and zinc white—**Pierre Ferrere**, Paris, France. Mar. 7, 1912.

The zinc in the ore to be treated is made water-soluble by a chloridizing or sulphatizing roast; the zinc chloride or sulphate freed from the other metals present, and then treated with lime and sulphurous acid, the lime being in the form of calcium bisulphite, which, in presence of excess of sulphurous acid, is immediately disintegrated through the zinc sulphate or chloride.

—Described in *Zeits. f. angewandte Chem.*, vol. 27, pt. II, p. 261. Apr. 17, 1914.

- 681 271,136. Recovery of pure zinc oxide from impure oxides which contain also lead oxide.—**Heinrich Heilmann**, Berlin. Nov. 14, 1912.

The lead oxide is separated by leaching with caustic potash and electrolyzing.

—Described in *Zeits. f. angewandte Chem.*, vol. 27, pt. II, pp. 261-62. Apr. 17, 1914.

- 682 271,658. Process for recovering zinc from calamine, especially from ores of low zinc content, as also from smelter residues, by leaching with ammonia.—**Jozef Jerzy Boguski**, Warsaw, and **Aktien-Gesellschaft fuer Bergbau und Huettenbetrieb**. Feb. 23, 1912.

—Described in *Zeits. f. angewandte Chem.*, vol. 27, pt. II, pp. 257-58. Apr. 17, 1914.

- 683 273,064. Production of an iron-free zinc solution from solutions containing iron oxide.—**Wilhelm Buddeus**, Charlottenburg, Germany. Dec. 12, 1912.

- 684 275,308. Treatment of sulphide ores or metal-bearing solutions for the recovery of zinc.—**Edgar A. Ashcroft**, Sogn, Norway. Apr. 25, 1912.

—Described in *Zeits. f. angewandte Chem.*, vol. 27, pt. II, p. 444. July 17, 1914.

- 685 278,621. Process for the treatment of sulphide ores for the production of metallic zinc.—**Edgar A. Ashcroft**, Sogn, Norway.

—Described in *Zeits. f. angewandte Chem.*, vol. 27, pt. II, p. 632. Nov. 13, 1914.

- 686 284,982. Process for the treatment of zinciferous ores with sulphurous acid.—**Erzverwertungs-Gesellschaft m. b. H.** Apr. 25, 1913.

Bisulphite process.

—Described in *Jour. Soc. Chem. Ind.*, vol. 34, p. 1100. Nov. 15, 1915.

687 285,617. Process for the recovery of pure zinc oxide or pure metallic zinc by treating a purified solution of zinc salts with ammonium sulphite, regenerating the spent ammonium sulphite, and calcining the resulting zinc sulphite.—**Henry William, baron de Stuckle**, Lieuze, Lorraine. Dec. 8, 1912.

—Described in *Zeits. f. angewandte Chem.*, vol. 28, pt. II, p. 435. Aug. 20, 1915.

687a 304,937. Process for the recovery of zinc from waste liquors containing zinc and sodium sulphates.—**Otto Bimpage**, Duisburg-am-Rhein. April 11, 1918.

—Abstract. *Zeits. f. angewandte Chem.*, vol. 31, p. 138. May 10, 1918.



WORKING FLOOR, REGENERATIVE TYPE DISTILLATION FURNACE
AMERICAN ZINC, LEAD & SMELTING CO.

SMELTING

Retort smelting

- 688 Die amerikanische Zinkindustrie in bezug auf den Charakter der den Huetten eingelieferten Zinkerze.—**W. R. Ingalls**. Metallurgie, vol. 1, pp. 377-81. Sept. 22, 1904.

- 689 Aus der Metallurgie des Zinks.—**Franz Juretzka**. diagr. Metall u. Erz, vol. 12, pp. 63-69, 94-102. Feb. 22, Mar. 8, 1915.

Discusses ore-dressing, wet chemical treatment, pyro-chemical treatment, muffles, and smelting, suggests partial reduction of zinc in the muffle, then roasting with coke; CO gas is formed, burned with air and used to heat the muffles. Zinc oxide is condensed in the dust chambers.

- 690 Beitrage zur Metallurgie des Zinks.—**H. Brandhorst**. diagr. Zeits. f. angewandte Chem., vol. 17, pp. 505-17. Apr. 15, 1904.

Details and problems arising in smelting, with especial reference to Silesian practice. The last three pages are on electrolytic methods.—Abstract. Jour. Soc. Chem. Ind., vol. 23, p. 491. May 16, 1904.

- 691 Beitrage zur Chemie des Zinkhuettenprozesses.—**Viktor Lepiarczyk**. Metallurgie, vol. 6, pp. 409-19. July 8, 1909.

A discussion of various chemical problems and difficulties involved in roasting and smelting. Presence of iron in the blende causes the roasting to be incomplete. Lime causes losses of sulphur by formation of calcium sulphate. See also item 770.

—Abstract: Contributions to the chemistry of zinc smelting. Jour. Soc. Chem. Ind., vol. 28, pp. 838-39. Aug. 16, 1909.

—Same abstract. Eng. & Min. Jour., vol. 88, p. 604. Sept. 25, 1909.

—Abstract: Chemistry of zinc smelting. Min. Jour., vol. 86, p. 326. Sept. 4, 1909.

—Abstract: Metallurgical chemistry of zinc. Min. Mag., vol. 1, p. 322. Dec., 1909.

—Abstract: Chemistry of smelting. Min. Sci., vol. 60, p. 85. Dec. 23, 1909.

—Abstract: Roasting of zinc ores. Jour. Inst. Metals, vol. 2, pp. 295, 321. 1909.

—Abstract: Chemistry of zinc smelting. Mex. Min. Jour., vol. 9, no. 6, p. 26. Dec., 1909.

- Abstract: Zinc smelting. Mex. Min. Jour., vol. 12, no. 6, p. 18. June, 1911.
- Same abstract, in Spanish. Mex. Min. Jour., vol. 12, no. 4, pp. 52-53. April, 1911.
- Abstract: Effect of impurities on roasting and distillation process. Met. & Chem. Eng., vol. 8, pp. 44-45. Jan., 1910.
- Abstract, in German. Zeits. f. angewandte Chem., vol. 22, p. 1943. Oct. 1, 1909.
- 692 Beitrag zur Metallurgie des Zinkes.—**Paul Schmieder.** diagr. Metallurgie, vol. 2, pp. 20-26. Jan. 8, 1905.
 Methods and chemistry of the smelting process. See also criticism by Schuchard, item 850.
- Abstract. Zeits. f. angewandte Chem., vol. 18, p. 1326. Aug. 18, 1905.
- 693 Beitrag zur Verarbeitung von Blenden mit kalkhaltiger Gangart.—**L. Bisschopinck.** Metallurgie, vol. 3, pp. 726-27. Nov. 8, 1906.
 Presence of CaSO_4 is not the reason for difficulty in smelting, but "lack of sufficient heat, which may be due to too low a temperature in the muffle, to too short a period of reduction, or both."
 Experience at the Godullahuette, Upper Silesia.
- Abstract: Smelting blende containing calcareous gangue. Eng. & Min. Jour., vol. 82, p. 1216. Dec. 29, 1906.
- Abstract: Working up of blendes with calcareous gangue. Jour. Soc. Chem. Ind., vol. 26, p. 51. Jan. 31, 1907.
- 694 Betrachtungen ueber die Waermebilanz eines Siemens-Zinkofens.—**F. Eulenstein.** diagr. Metallurgie, vol. 9, pp. 328-34, 353-62, 396-403. May 22, June 8, 22, 1912.
 "A remarkably competent and painstaking study of the heat balance of a Siemens zinc distillation furnace."
- Abstract. Mineral Industry, vol. 21, p. 893. 1912.
- 695 Blendische Bleiglanze. Metallurgie, vol. 1, p. 89. Mar. 8, 1904.
 Miller's English Patent 20,465 of 1902. Separation of zinc and lead in distillation. Experiments on Broken Hill ores.
- 696 Cadmium recovery in zinc smelting.—**D. M. Liddell.** Mineral Industry, vol. 19, pp. 91-92. 1910.
- 697 Calculation of the latent heat of vaporization of zinc.—**Woolsey McA. Johnson.** Amer. Electrochem. Soc., Trans., vol. 14, pp. 251-53. 1908.
 Calculation by use of thermodynamics, "422 calories is a close enough figure for practical purposes."
- Abstract: Vaporization of zinc. Electrochem. & Met. Ind., vol. 6, p. 495. Dec., 1908.

- Abstract, in German. Zeits. f. angewandte Chem., vol. 22, p. 205. Jan. 29, 1909.
- 698 The chemical and physical reactions in a zinc retort.—**F. L. Clerc.** Met. & Chem. Eng., vol. 10, pp. 399-401. July, 1912.
- 699 Complex zinc ores. Min. Mag., vol. 10, pp. 408-9. June, 1914.
- 700 Controlling the formation of zinc dust in smelting. Met. & Chem. Eng., vol. 12, pp. 530-31. Aug., 1914.
 Alex Roitzheim's Patent 1,100,490 Preheating the smelting charge to a temperature of about 600° C. before placing it in the retort.
- 701 Development of zinc smelting in the United States.—**George C. Stone.** Met. & Chem. Eng., vol. 13, pp. 726-27. Oct. 15, 1915.
 Historical review describing a number of processes. Abstract of a paper at the International Engineering Congress, San Francisco, September, 1915.
- 702 Distillation process with internal heating. diagr. Electrochem. & Met. Ind., vol. 4, pp. 461-62. Nov., 1906.
 H. Mehner's Patent 833,472.
- 703 Distillation without retorts. Electrochem. & Met. Ind., vol. 4, pp. 371-72. Sept., 1906.
 Armstrong's Patent 830,293.
- 704 A dry process for the treatment of complex sulphide ores. **H. L. Sulman** and **H. F. Kirkpatrick-Picard.** Inst. Min. & Met., Trans., vol. 10, pp. 430-56. 1902.
 Work on Broken Hill ores; gives costs.
 —Abstract. Eng. & Min. Jour., vol. 74, pp. 112-13. July 26, 1902.
 —Abstract. Jour. Soc. Chem. Ind., vol. 21, p. 975. July 31, 1902.
 —Abstract. Mineral Industry, vol. 11, pp. 612-13. 1902.
- 705 Du Role du sulfate de calcium et du sulfate de baryum dans la reduction des mineraux de zinc.—**Eugene Prost** and **Maurice Ubahs.** Bull. Soc. Chim. Belge., vol. 26, pp. 532-41. 1912.
 Effect of calcium and barium sulphates in the reduction of zinc ores.
 —Same, in French. Rev. Univ. des Mines, Nov., 1912.
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- 706 Examination of the reactions occurring in the metallurgical treatment of blende.—**Eugene Prost.** Bull de l'Assoc. Belge des Chim., vol. 10, pp. 212-25, 246-63. 1896.
Reactions of iron oxide and zinc oxide; reducing action of carbon; other reactions. In French.
—Abstract. Jour. Soc. Chem. Ind., vol. 15, pp. 723, 813-14. Oct. 31, Nov. 30, 1896.
- 707 Die Fortschritte in oberschlessischen Zinkhüttenbetriebe.—**A. Rzechulka.** Oester. Zeits. f. Berg- u. Hüttenw., vol. 54, pp. 133-37. 1906.
Advance in zinc smelting practice in Upper Silesia.
- 708 Gattierung und Destillation im Zinkhüttenbetriebe.—**Franz Juretzka.** diagr. Metallurgie, vol. 8, pp. 1-7. Jan. 8, 1911.
Mixing of ores and temperature control in smelting. Paper at the Conference of Rhenish and Belgian Zinc Smelters at Cologne, April, 1910.
—Abstract: Mixing and distilling zinc ores. Min. Wld., vol. 34, p. 347. Feb. 11, 1911.
—Abstract: Grading and distillation of zinc ores. Jour. Inst. Metals, vol. 5, p. 298. 1911.
- 709 Gattierung von Zinkblende und Galmei.—**Franz Juretzka.** Metallurgie, vol. 4, pp. 84-90. Feb. 8, 1907.
"Discusses very briefly the historical aspect of zinc smelting practice, and gives in detail the present state of the art of reducing zinc from mixtures of calamine and blende; also discusses the principles which govern the composition of the mixtures to be smelted."—E. & M. J.
—Same. Zeits. f. angewandte Chem., vol. 20, pp. 750-54. May 3, 1907.
- 710 Die gegenwaertigen Aussichten der Verhüttung von Zinkerzen in den Vereinigten Staaten.—**W. R. Ingalls.** Metallurgie, vol. 1, pp. 329-34. Aug. 22, 1904.
American zinc smelting methods.
- 711 Gewinnung von metallischem Zink oder Zinkstaub aus schwefelzinkhaltigen Materialien, z. B. Zinkblende. Metallurgie, vol. 9, pp. 490-91. Aug. 8, 1912.
Recovery of metallic zinc or zinc dust from sulphide materials. K. Friederich's German Patent 244,873.
- 712 Gewinnung von Rohzink aus zinkhaltigen Materialien mit Hilfe von Carbiden. Metallurgie, vol. 9, p. 460. July 22, 1912.
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- 713 Gewinnung von Zink aus seinen oxydischen oder Schwefelerzen oder aus Gemischen von solchen. Metallurgie, vol. 7, pp. 344-45. June 8, 1910.

Imbert's German Patent 218,408, for production of zinc from its oxides or sulphides or from a mixture of both, using a solution of Fe_2O_3 .

- 714 Gewinnung von Zink durch Destillation. Metallurgie, vol. 9, p. 493. Aug. 8, 1912.
Specketer's German Patent 245,681.
- 715 Gleichzeitige Gewinnung von Kupfer und Zink aus an Zink reichen Schwefelkupfererzen. Metallurgie, vol. 9, pp. 493-94. Aug. 8, 1912.
Simultaneous recovery of copper and zinc from copper sulphide ores rich in zinc. German Patent 245,847, by Societe Commerciale des Mines, Minerais, et Metaux, Paris.
- 716 Historical note on zinc smelting.—**Herbert C. and L. H. Hoover.** In their translation of **Agricola's** De Re Metallica, Book ix, footnote, pp. 408-10.
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- 717 History of smelting in the Joplin district.—**Doss Brittain.** illus. Eng. & Min. Jour., vol. 84, pp. 861-67. Nov. 9, 1907.
- 718 Improvements in the metallurgy of zinc.—**George C. Stone.** Amer. Electrochem. Soc., Trans., vol. 25, pp. 161-68. 1914.
Discussion showing that improvements in zinc metallurgy have been as great as in the metallurgy of copper and iron.
—Same. Min. Wld., vol. 40, pp. 465-67. Mar. 7, 1914.
—Abstract: Improvements in the retort process. Met. & Chem. Eng., vol. 11, p. 677. Dec., 1913.
—Abstract: Belgian furnaces in zinc smelting. Min. & Sci. Press, vol. 107, pp. 931-32. Dec. 13, 1913.
- 719 Influence of temperature and pressure on the volatility of zinc and cadmium.—**T. K. Nair and T. Turner.** diagr., graphs. Jour. Chem. Soc., vol. 103, pp. 1534-43. 1913.
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- 720 Influence of the degree of desulphurising upon the yield of zinc from zinc blende.—**Eugene Prost.** Bull. de l'Assoc. Belge des Chim., vol. 14, pp. 125-31. 1900. In French.
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—V. Lindt. *Metallurgie*, vol. 6, pp. 747-49. Dec. 8, 1909.
Zinc losses caused by the presence of lime and magnesia.
—Abstract: Zinc ores containing lime and their economical treatment. *Jour. Soc. Chem. Ind.*, vol. 29, p. 93. Jan. 31, 1910.
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- 722 Labour problems in zinc smelting. *Min. Mag.*, vol. 14, pp. 133-35. Mar., 1916.
Editorial. "How changes in the labour situation have been met by alterations in furnaces and in organization." See also correspondence by Dewar, item 262.
- 723 Lead and zinc in the United States.—W. R. Ingalls. N. Y., Hill Publishing Co., 1908. 368 pp. illus. 8°.
Zinc smelting is discussed on pp. 309-335.
—Reviewed by R. W. Raymond. *Eng. & Min. Jour.*, vol. 86, pp. 129-30. July 18, 1908.
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"A complete tabulation of the construction and operating details of the European zinc smelteries."
- 726 Losses in zinc smelting.—H. Martin. *Engineering*, Oct. 6, 1916.
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Problems of reduction and condensation in retort smelting.
- 729 The method of extracting zinc in Australia.—John Plummer. illus. *Min. Wld.*, vol. 20, pp. 711-12. Nov. 7, 1908.
"Method of recovering zinc from several million tons or so-called waste from the Broken-Hill silver-lead mines."

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Continuous zinc distillation in vertical retorts by the Roitzheim-Remy process, mechanically removing the residue at intervals.
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Smelting practice in America and Europe, including cost data.
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Checker Chambers under Working Floor

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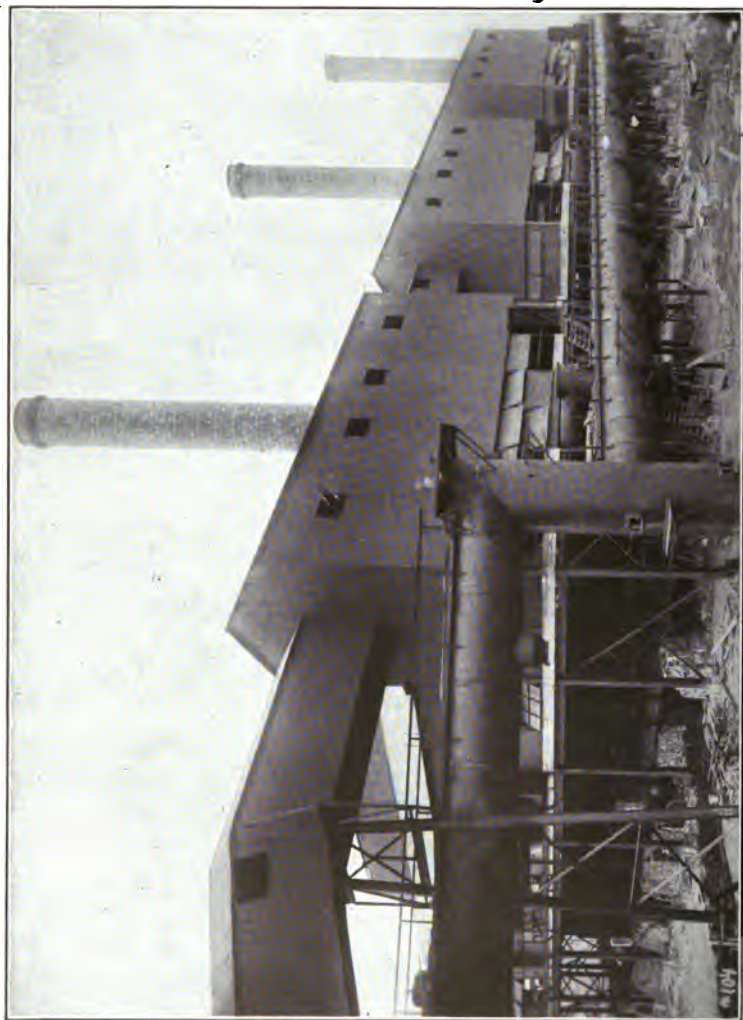
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Truax's Patent 1,155,628. The slag is melted in a reverberatory furnace, the hearth of which is composed of reducing material.

- 904 Reduction furnace. diagr. *Electrochem. & Met. Ind.*, vol. 5, pp. 241-42. June, 1907.
De Laval's rotary furnace and its mode of operation.
- 905 Reduction of zinc. diagr. *Eng. & Min. Jour.*, vol. 89, p. 974. May 7, 1910.
Loiseau's Patent 947,831; furnace for the reduction of oxidized ores by carbon monoxide.
- 906 The sulphur smoke question in Germany.—**Alfred Gradenwitz.** *Eng. & Min. Jour.*, vol. 84, p. 311. Aug. 17, 1907.
Government regulations concerning zinc roasting and smelting.
- 907 Die technische Bedeutung der Staubfrage fuer Zinkhuetten.—**Oscar Gerold.** illus. *Metall u. Erz.*, vol. 12, pp. 403-10, 419-36. Oct. 8, 22, 1915.
Technical importance of the dust problem in zinc smelting. Methods for dust prevention.
- 908 Verarbeitung von Zinkerzen bei gleichzeitiger Gewinnung von metallischem Blei- und Zink-oxyd. *Metallurgie*, vol. 9, p. 338. May 22, 1912.
Witter's German Patent 240,365; simultaneous recovery of lead and zinc from mixed lead-zinc sulphide ores.
- 909 Verfahren und Ofen zur Scheidung und Gewinnung von Metallen und Metalloxyden aus fluessigen Schlacken und Schmelzen durch Anwendung von Reduktionsmitteln allein oder in Verbindung mit Reaktionsmitteln im Flammofen. diagr. *Metall u. Erz*, vol. 11, p. 433. June 22, 1914.
Adolphe Desgraz's German Patent, 293,047, for an oven and process for refining and winning metals and metal oxides from fluid slags by means of reduction methods alone, or in connection with reactions in the reverberatory oven.
- 910 Zinc refining.—**Bruno Kerl.** *Mineral Industry*, vol. 5, pp. 611-18. 1896.
Effect of the various impurities in crude zinc; refining method of Hohenloehuetzte; other methods; electrolytic zinc.
- 911 Zinc refining. *Electrochem. & Met. Ind.*, vol. 6, p. 381. Sept., 1908.
Ziesing's Patent 893,415.

Production of Zinc Oxide

- 911a Baghouses for zinc oxide.—**John F. Cregan.** illus., diagr. *Eng. & Min. Jour.*, vol. 106, pp. 126-32. July 20, 1918.
- 912 The Blum zinc oxide process. diagr. *Eng. & Min. Jour.*, vol. 92, pp. 603-4. Sept. 23, 1911.

- U. S. Patent 993,019. Claims that "the Huntington-Herberlein pot is adapted to the manufacture of zinc oxide. Advantages claimed are larger charges, less contamination of the oxide with iron, and production of an easily discharged porous clinker." See also item 918.
- Abstract: Zinc oxide. *Min. Mag.*, vol. 5, p. 312. Oct., 1911.
- 913 Collecting zinc oxide fume. *Met. & Chem. Eng.*, vol. 12, p. 140. Feb., 1914.
Reynold's Patent 1,082,766; a substitute for canvas bags, in the form of apparatus with mechanical means for scraping the oxide from the collecting medium.
- 914 Equipment of a zinc oxide plant. *Min. Wld.*, vol. 28, p. 796. May 16, 1908.
Ozark Zinc Oxide Works, Coffeyville, Kansas.
—Same. *Electrochem. Met. Ind.*, vol. 6, p. 305. July, 1908.
- 915 An experimental plant for saving zinc oxide.—**Paul Speier.**
Eng. & Min. Jour., vol. 84, p. 217. Aug. 3, 1907.
Details of an experimental plant at the Rosamunde works in Germany.
- 916 Die Gewinnung des Zinks aus dem zinkhaltigen Schlacken der unterharzer Huettenbetriebe.—**Hermann Pape.**
Glueckauf, vol. 46, pp. 237-39. Feb. 19, 1910.
At the Harz mines at Oker, Germany the slag is ground, briquetted and reduced in a continuous reverberatory furnace, recovering zinc oxide. Wet methods were unsuccessful.
—Same: Treatment of complex zinc sulphide ores at Oker. *Eng. & Min. Jour.*, vol. 89, pp. 819-21. Apr. 16, 1910.
—Abstract. *Min. Mag.*, vol. 2, p. 228. Mar., 1910.
- 917 Gewinnung von verfluechtigem Zink-oxyd aus zinnhaltigen Rohstoffen durch die vereinigte Einwirkung von Kohlenstoff und Luft. *diagr. Metallurgie*, vol. 7, p. 128. Feb. 22, 1910.
Recovery of volatilized zinc oxide from tin-bearing materials under the combined action of carbon and air. German Patent 214,735, by H. Muehlinghaus.
- 918 The Hommel furnace for volatilizing zinc.—**W. Hommel.**
diagr. Eng. & Min. Jour., vol. 92, p. 1164. Dec. 6, 1911.
Disputes originally of claims of Blum patent, (item 912). Compares zinc oxide processes; discusses causes of variation in products and the features of the Hommel furnace.
—Abstract: Zinc oxide. *Min. Mag.*, vol. 6, p. 64. Jan., 1912.
- 919 The lead and zinc pigments.—**Clifford D. Holley**, N. Y., John Wiley & Sons, 1909. 340 pp. illus. 8°.
Manufacture of zinc oxide, pp. 152-74.

- 920** Manufacture of zinc oxide. diagr. *Met. & Chem. Eng.*, vol. 12, p. 790. Dec., 1914.
J. A. Singmaster's Patents 1,112,853-854; continuous process of producing zinc oxide. Claims improvement on the Wetherill process using stationary grates.
- 920a** The manufacture of zinc oxide at Monteponi.—**F. Sartori.**
Eng. & Min. Jour., vol. 106, p. 742. Oct. 26, 1918.
Abstract of a paper in *Resoconti delle Riunioni dell' Associazione Mineraria Sarda*, Dec., 1917.
- 921** Oxide of zinc.—**George C. Stone.** diagr. *Amer. Inst. Min. Eng., Trans.*, vol. 57, pp. 682-95. 1917.
"The making of oxide of zinc at Palmerton, Pa., from the products of the New Jersey Zinc Company's Franklin and Sterling Forest mills." Origin and development of the process.
—Same. diagr. *Amer. Inst. Min. Eng., Bull.* 129, pp. 1217-18. Sept., 1917.
—Same. diagr. *Met. & Chem. Eng.*, vol. 17, pp. 308-13. Sept. 15, 1917.
—Same: Making zinc oxide at Palmerton plants of New Jersey Zinc Co. *Eng. & Min. Jour.*, vol. 104, pp. 508-12. Sept. 22, 1917.
—Abstract. *Min. & Sci. Press*, vol. 115, pp. 759-62. Nov. 24, 1917.
- 922** Production of zinc oxide from low-grade carbonate ore at Leadville. illus. *Met. & Chem. Eng.*, vol. 13, pp. 631-33. Sept. 15, 1915.
Describes plant and operations; Western Zinc Oxide Co., using a Wetherill furnace.
- 923** Pyrometallurgy of zinc-lead ores. *Met. & Chem. Eng.*, vol. 11, p. 160. Mar., 1913.
Witter's Patent 1,047,360.
- 924** The treatment of zinc-lead sulphide ores.—**F. L. Bartlett.**
Mineral Industry, vol. 5, pp. 619-32. 1896.
Author's smelting method as used at Canon City, Colo.
- 925** Zinc from low-grade complex ores. *Min. & Sci. Press*, vol. 115, p. 827. Dec. 8, 1917.
Editorial note on igneous concentration of oxide ores.
- 926** Zinc burning as a metallurgical process.—**W. R. Ingalls.**
illus. *Amer. Inst. Min. Eng., Trans.*, vol. 57, pp. 696-701. 1917.
"Zinc burning is suggested as a designation of the practice of igneous concentration of zinc ores. It seems destined to receive a wider application than the mere making of zinc oxide for pigment."
—Same. illus. *Amer. Inst. Min. Eng., Bull.* 129, pp. 1229-34. Sept., 1917.

- Same, extended. Eng. & Min. Jour., vol. 104, pp. 457-61. Sept. 15, 1917.
- Abstract. Min. & Sci. Press, vol. 115, p. 432. Sept. 22, 1917.
- Abstract. Met. & Chem. Eng., vol. 17, pp. 519-20. Nov. 1, 1917.
- Abstract. Jour. Soc. Chem. Ind., vol. 36, pp. 1131-32. Nov. 15, 1917.
- 927 Zinc oxide. Electrochem. & Met. Ind., vol. 6, pp. 79-80. Feb., 1908.
Pape's Patent 877,114.
- 928 Zinc-oxide and zinc-lead pigment manufacture; how the process requiring pure zinc ores and anthracite fuel was made suitable for complex ores and the use of soft coal.—**William F. Gordon.** illus. diagr. Eng. & Min. Jour., vol. 83, pp. 1033-36. June 1, 1907.
- 929 Zinc oxide from lead blast furnace slag, as in operation at South Chicago.—**H. B. Pulsifer.** illus. Met. & Chem. Eng., vol. 13, pp. 783-85. Nov. 1, 1915.
"The process consists of smelting the refinery slags in the lead blast furnace with additional lime and considerable coke in the charge; the furnace is run with hot top, and the heavy zinc fume is collected in bags as the finished product of the operation."
—Same. Mex. Min. Jour., vol. 20, pp. 433-34. Dec., 1915.
—Abstract: Recovery of zinc oxide from slag. Min. Mag., vol. 13, pp. 342-43. Dec., 1915.
- 930 Zinc oxide from lead slag.—**H. B. Pulsifer** and **George Perlstein.** illus. Min. & Sci. Press, vol. 114, pp. 161-63. Feb. 3, 1917.
- 931 Zinc oxide furnaces.—**John F. Cregan.** diagr. Eng. & Min. Jour., vol. 104, pp. 675-80. Oct. 20, 1917.
"Two general types of zinc oxide furnaces have been developed in the United States as a result of the diverse conditions in ore and fuel supply. Eastern works use a series of separately controlled rates, the zinc fumes passing to a common collecting flue. Western metallurgists prefer a self-contained unit, individual charges controlled by the balance of the whole furnace. The author considers that the Western practice is best adapted to varied ores and fuels."
—E. & M. J.
- 931a Zinc oxide in slags.—**W. Maynard Hutchings.** Eng. & Min. Jour., vol. 79, pp. 959-60. Dec. 24, 1903.
"In slags which are not too basic, zinc oxide is combined as silicate."
—Abstract. Mineral Industry, vol. 12, p. 364. 1903.

- 932 Zinc oxide process utilizing zinc waste. *Min. Wld.*, vol. 35, p. 1004. Nov. 18, 1911.
 Hommel's Patent 1,002,401. "The wastes which accumulate about zinc works contain coke and carbonaceous matter and some zinc. These wastes are used, with the addition of fresh ore, for the production of zinc oxide." See also item 377.

- 933 Zinc smelting for pigment.—**Evans W. Buskett.** illus. *Min. & Sci. Press*, vol. 97, pp. 604-5. Oct. 31, 1908.
 Method of smelting at Coffeyville.

Smelting Plants

- 934 Active zinc smelters of the United States.—**C. E. Sieben-thal.**

A statistical list arranged by states and companies, showing the retort capacity of each plant, is published in the U. S. Geological Survey's annual compilation, "Mineral Resources of the United States." The same list is usually published in the annual volumes of "The Mineral Industry" and of the "Mines Handbook", and in the early January numbers of the *Engineering and Mining Journal*, the *Mining and Scientific Press*, and other mining periodicals. The latest list is included elsewhere in this Bibliography.

- 935 The American Steel & Wire Company's zinc works. illus. *Iron Age*, vol. 97, pp. 82-86. Jan. 6, 1916.
 Plant at Donora, Pa., operated in 104 days from start of building.
 —Abstract: The Donora zinc works. *diagr. Min. Mag.*, vol. 14, p. 114. Feb., 1916.

- 936 The American zinc smelter at Hillsboro, Illinois.—**Carpel L. Breger.** illus. *Min. Wld.*, vol. 37, pp. 847-50. Nov. 9, 1912.

- 937 Die Anlage von Zinkhuetten.—**Franz Juretzka.** *Zentralblatt der Huetten- und Walzwerke*, 1912.
 A book on the construction of zinc smelters.

- 938 The Central Zinc Company's works at Seaton Carew. illus. *diagr. Engineering*, vol. 80, pp. 141-44. Jan. 29, 1909.
 —Abstract: The Central Zinc Co. *diagr. Eng. & Min. Jour.*, vol. 88, pp. 777-78. Oct. 16, 1909.

- 939 Collinsville smelter of the Bartlesville Company.—**E. H. Leslie.** illus. *Min. & Sci. Press*, vol. 109, pp. 204-8. Aug. 8, 1914.
 —Abstract, in German. *Metall u. Erz*, vol. 11, pp. 719-20. Dec. 22, 1914.

- 940 Costs and profits of an up-to-date spelter works.—**J. Gilbert.** *Min. Jour.*, vol. 114, pp. 480-81, 496-98. July 8, 15, 1916.

"A practical consideration of the subject" from an English point of view.

- 941 Deering plant at American Zinc, Lead & Smelting Company.—**Evans W. Buskett.** illus. Eng. & Min. Jour., vol. 90, pp. 502-3. Sept. 10, 1910.
- 942 The Donora Zinc Works.—**W. R. Ingalls.** illus. Eng. & Min. Jour., vol. 102, pp. 648-54. Oct. 7, 1916.
Plant of the American Steel & Wire Co.
- 943 Eine Exkursion auf nordamerikanische-mexikanische Blei-, Zink-, und Kupferhuetten.—**F. Heberlein.** illus. Metall u. Erz, vol. 10, pp. 716-25. Aug. 30, 1913.
—Same: An excursion to North American smelting works; translated by Herbert Haas. Min. & Sci. Press, vol. 107, pp. 713-18. Nov. 8, 1913.
—Abstract: Lead, zinc and copper smelting in America; by O. H. Hahn. illus. Eng. & Min. Jour., vol. 96, pp. 871-75, 909-12. Nov. 8, 15, 1913.
- 944 Die Huetten der Aktien-Gesellschaft fuer Bergbau, Blei- und Zinkfabrikation zu Stolberg und in Westfalen. Metallurgie, vol. 1, pp. 115-17. Apr. 8, 1904.
- 945 Improvements at Trail, B. C. Eng. & Min. Jour., vol. 99, p. 290. Feb. 6, 1915.
Lead, zinc and copper smelting.
- 946 Mill and smelter construction in 1916. illus. Min. Wld., vol. 46, pp. 1-28. Jan. 6, 1917.
Describes several important smelters and electrolytic plants. Similar annual reviews of progress appear in the early January numbers of previous years, of the same journal.
- 947 The Mineral Point zinc works. illus. Eng. & Min. Jour., vol. 82, pp. 388-91. Sept. 1, 1906.
Makes sulphuric acid and zinc oxide.
- 948 The Nassau zinc works at Depue, Illinois.—**E. H. Leslie.** illus., map. Min. & Sci. Press, vol. 109, pp. 475-80. Sept. 26, 1914.
—Abstract, in German. Metall u. Erz, vol. 11, pp. 721-22. Dec. 22, 1914.
- 949 The National Zinc Company, Bartlesville, Okla.—**E. H. Leslie.** illus. diagr. Min. & Sci. Press, vol. 109, pp. 136-41. July 25, 1914.
—Abstract, in German. Metall u. Erz, vol. 11, pp. 718-19. Dec. 22, 1914.

- 950 The new zinc smeltery at Langeloth.—**W. R. Ingalls.** diagr. Eng. & Min. Jour., vol. 98, pp. 985-89. Dec. 5, 1914.
Plant of the American Zinc & Chemical Co., near Pittsburgh, Pa. Roasting and smelting furnaces are of the Hegeler type.
- 951 The Palmerton works of the New Jersey Zinc Company.—**O. Pufahl.** Zeits. f. Berg-, Huetten-, u. Salinenwesen im Preuss. Staate, vol. 53, p. 400. 1905. In German.
—Abstract. Zeits. f. angewandte Chem., vol. 20, p. 1744. Oct. 4, 1907.
—Abstract. Eng. & Min. Jour., vol. 81, p. 273. Feb. 10, 1906.
- 952 Power plant of Granby Mining and Smelting Co. illus. Eng. & Min. Jour., vol. 100, pp. 113-15. July 17, 1915.
- 953 The Rose Lake smelter of the Granby Company.—**F. H. Leslie.** illus., diagr. Min. & Sci. Press, vol. 109, pp. 395-402. Sept. 12, 1914.
—Abstract: The Rose Lake zinc-smelter. diagr. Min. Mag., vol. 11, p. 263-64. Oct., 1914.
—Abstract, in German. Metall u. Erz, vol. 11, pp. 720-21. Dec. 22, 1914.
- 954 Ueber die Zinkgewinnung in Dombrowa.—**A. W. Schrubko.** diagr. Metallurgie, vol. 1, pp. 151-56, 178-82. Apr. 22, May 8, 1904.
- 955 Van Buren smelting plant.—**F. W. Bocking.** illus. Eng. & Min. Jour., vol. 102, pp. 655-58. Oct. 7, 1916.
Plant of Arkansas Zinc & Smelting Corporation.
- 956 Works of American Zinc & Chemical Co., at Langeloth. Eng. & Min. Jour., vol. 102, p. 816. Nov. 4, 1916.
- 957 The zinc industry of upper Silesia. Eng. & Min. Jour., vol. 76, p. 120. July 23, 1903.
Statistics for 1901 of several smelters.
- 958 Zinc-lead smelting plant at Ekibastus, Siberia. Eng. & Min. Jour., vol. 103, p. 266. Feb. 10, 1917.
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- 959 Zinc manufacture in the Pittsburg district. illus. Iron Age, vol. 95, pp. 1064-67. May 13, 1915.
American Zinc & Chemical Co., at Langeloth.
- 960 Zinc smelting at Bartlesville, Okla.—**E. H. Leslie.** illus., diagr. Min. & Sci. Press, vol. 109, pp. 44-49. July 11, 1914.

- Abstract, in German. *Metall u. Erz*, vol. 11, pp. 716-18. Dec. 22, 1914.
- 961 Zinc reduction. *Min. Jour.*, vol. 107, pp. 961, 1004, 1011, 1026; vol. 108, pp. 8-9, 21. Nov. 4, 28, Dec. 5, 12, 1914; Jan. 2, 9, 1915.
Correspondence and discussion on the cost of erecting spelter plants in England.
- 962 Zinc smelting at Hillsboro, Illinois.—**E. H. Leslie**, illus. *Min. & Sci. Press*, vol. 109, pp. 280-86. Aug. 22, 1914.
Plant and methods of the American Zinc, Lead and Smelting Company.
—Abstract, in German. *Metall u. Erz*, vol. 11, pp. 644-46. Oct. 22, 1914.
- 963 Zinc smelting in the middle West.—**E. H. Leslie**, San Francisco, *Min. & Sci. Press*, 1915. 40 pp. illus. paper.
A reprint of the six articles published in the *Min. & Sci. Press*.
- 964 The zinc smelting works at Vado Ligure.—**Erminio Ferraris**, diagr. *Eng. & Min. Jour.*, vol. 106, p. 212. Aug. 3, 1918.
Italian smelter operated by waste gas from coke manufacture.



POTTERY DEPARTMENT, AMERICAN ZINC, LEAD & SMELTING CO.
Retort discharged from Hydraulic Press

PATENTS ON SMELTING

United States

- 965 448,802. Process of refining zinc.—**Joseph W. Richards**, Philadelphia, Pa. Filed September 27, 1890. Issued March 24, 1891.

The process of refining zinc, which consists in diffusing metallic aluminum throughout a bath of melted zinc, permitting said composite bath to stand in a melted condition for the subsidence of impurities, and finally removing the stratum of refined zinc.

- 966 453,529. Process of smelting sulphides.—**William L. Austin**, Toston, Mont. Filed Feb. 28, 1889. Issued June 2, 1891.

As an improvement in the art of smelting pyrites, blende, sulphurets, or sulphides, the method of securing continued combustion and smelting without the necessity of the continued use of carbonaceous fuel, which consists in first heating the lower part of a charge containing one or more of the substances or compounds up to a point where combustion can take place, and then subjecting the charge to the action of a hot-air blast and continuously drawing the molten products as formed away from the path of the blast.

- 967 453,806. Apparatus for treating ores.—**Eduard Grützner**, Romagna Grube, near Loslau and **Oscar Koehler**, Czer-nitz, Germany. Filed Mar. 8, 1890. Issued June 9, 1891.

- 968 469,104. Zinc-furnace.—**Hermann G. Tessmer**, Pittsburg, Kans. Filed Aug. 19, 1890. Issued Feb. 16, 1892.

- 969 476,789. Furnace for smelting zinc ores.—**Selwyn C. Edgar**, St. Louis, Mo. Filed July 30, 1891. Issued June 14, 1892.

- 970 478,110. Process of reducing zinc or spelter from ores.—**Christopher James**, Swansea, England. Filed Aug. 18, 1891. Issued July 5, 1892.

A process for the commercial treatment of zinc-sulphide ores, consisting in first calcining a part of the ore in a calcining-furnace to the form of an oxide, mixing the calcined ore with rather more than half its weight of crude ore, and smelting the same in the hearth of a neutral or slightly-reducing reverberatory furnace until reduced to zinc and sulphur dioxide, the zinc being volatilized and collected by condensation in a chamber distinct from the furnace

- 971 482,438. Process of reducing zinc.—**Christopher James**, Swansea, England. Filed Dec. 28, 1891. Issued September 13, 1892.

A process for the treatment of sulphide-zinc ores, consisting of partially calcining the ore, discontinuing the calcination when a portion of the ore is brought to the condition of a sulphate, melting the partially calcined ore in a reverberatory or suitable furnace,

and collecting the volatilized zinc by condensation in a chamber distinct from the furnace. Patented also in England, no. 11,563 of 1891; in Belgium, no. 95,763; in Spain, no. 12,373 of 1891; in France, no. 215,113.

- 972 483,652. Process of reducing zinc.—**Christopher James**, Swansea, England. Filed Dec. 28, 1891. Issued October 4, 1892.

A process for the treatment of zinc ores, consisting in mixing any natural or other oxide of zinc with sulphur or sulphides of any metal, subjecting the same to a melting heat in a neutral or slightly reducing furnace, the relative proportions of the sulphur and oxides being such that the oxygen and sulphur will mutually react to entirely reduce the zinc to a metallic but vaporized condition, and collecting the latter by condensation.

- 973 483,934. Zinc-furnace.—**Octavius Lumaghi**, St. Louis, Mo. Filed Nov. 10, 1891. Issued Oct. 4, 1892.

- 974 489,460. Method of producing metallic zinc.—**Parker C. Choate**, New York, N. Y. Filed Dec. 9, 1891. Issued January 10, 1893.

The process of producing metallic zinc which consists in heating an ore of zinc carrying lead in the presence of a reducing agent in a furnace to which air is admitted so as to volatilize the zinc and lead and those constituents of the ore more volatile than zinc, thereby obtaining a zinc lead fume free from the less volatile constituents of the ore; reheating the fume to drive off the constituents more volatile than zinc; subjecting the fume mixed with carbon to heat in a retort; thereby obtaining molten lead and zinc vapors; condensing the zinc vapors in the presence of the molten lead; drawing off the resulting molten alloy, permitting the lead to settle, under the action of gravity and drawing off the superincumbent zinc.

- 975 489,461. Art of producing metallic zinc.—**Parker C. Choate**, New York, N. Y. Filed July 1, 1892. Issued Jan. 10, 1893.

The process of producing metallic zinc which consists in heating zinc fume mixed with lead fume or pulverized metallic lead, to granulate or condense the fume, heating the product mixed with carbon in a retort to distill the zinc, and finally condensing the zinc vapors and separating the metallic zinc and molten lead.

- 976 501,189. Process of manufacturing oxide of zinc.—**George T. Lewis**, Philadelphia. Filed Sept. 1, 1891. Issued July 11, 1893.

The method of treating zinc ores containing sulphur, for the manufacture of oxide of zinc which consists in mixing with the ore alkali sufficient to unite with the sulphur and coal sufficient to effect the sublimation of the zinc charging the mixture into zinc oxide furnaces and igniting it to effect the union of the alkali and sulphur and the sublimation of the zinc.

- 977 540,671. Apparatus for refining zinc spelter.—**Thomas J. Jones**, Pulaski City, Va. Filed Feb. 26, 1895. Issued June 11, 1895.

- 978 543,256. Process of and apparatus for extraction of zinc.—**Leo V. Lynen**, London, England. Filed Dec. 22, 1893. Issued July 23, 1895.

The process of extracting zinc which consists in enclosing the ore in non-metallic carbonizable envelopes, placing said envelopes in retorts, applying heat and condensing the zinc vapors.

- 979 554,185. Apparatus for refining zinc.—**George M. Holstein** and **John D. James**, Pulaski City, Va., assignor to the Bertha Mineral Company. Filed July 20, 1895. Issued February 4, 1896.

- 980 554,184. Process of, and apparatus for defining zinc.—**George M. Holstein** and **John D. James**, Pulaski City, Va., assignors to the Bertha Mineral Company. Filed May 27, 1895. Issued February 4, 1896.

The process of refining zinc and separating it from lead which consists in melting the spelter and causing the lead by its lower melting point, greater specific gravity, and higher volatilizing point to flow to a point of lower level, chilling the metal at this point, to hold the lead below its volatilizing-point and volatilizing and separating the zinc at a temperature below the volatilizing point of lead.

- 981 555,680. Smelting furnace.—**Christopher Cunningham, jr.**, Brooklyn, N. Y. Filed June 19, 1895. Issued March 3, 1896.

- 982 572,011. Smelting furnace.—**Herman Huber**, Kansas City, Mo. Filed June 22, 1895. Issued Nov. 24, 1896.

- 983 578,963. Smelting furnace.—**Charles Bishop**, Tacoma, Wash. Filed October 23, 1896. Issued March 16, 1897.

- 984 579,750. Manufacture of zinc oxide.—**Wilhelm Hampe** and **Carl Schnabel**, Hanover, Germany. Filed Aug. 1, 1896. Issued March 30, 1897.

The process for preparing zinc oxide consisting in subjecting an intimate mixture of finely divided and dried zinc sulphate and finely divided carbon to an even and correctly gaged temperature.

- 985 586,910. Smelting furnace.—**John D. McDonald**, Sudbury, Canada. Filed May 18, 1896. Issued June 20, 1897.

- 986 623,762 Smelting furnace.—**Charles Bishop**, Knoxville, Cal. Filed September 7, 1898. Issued April 25, 1899.

- 987 633,035. Smelting furnace.—**Joseph V. Otten**, Iola, Kans. Filed Feb. 3, 1899. Issued September 12, 1899.

- 988 645,178. Process of reducing easily-oxidizable Metals.—**Casper W. Miles**, Cincinnati, Ohio. Filed Dec. 28, 1898. Issued Mar. 13, 1900.

The process of reducing zinc ore which consists in supplying air to a body of fuel, passing the products of combustion around a mass of the ore and carbon, subdividing the current of said products of combustion, passing a portion thereof through said mass of ore and carbon, cooling the vapor so produced and thereby condensing the metallic fumes, mixing the uncondensed residual gas with the remaining portion of the current of the products of combustion and conveying them in contact with the raw ore.

- 989 645,179. Apparatus for reducing zinc.—**Casper W. Miles**, Cincinnati, Ohio. Filed Sept. 25, 1899. Iss. Mar. 13, 1900. 8 claims.

- 990 652,076. High-temperature smelting-furnace.—**Wilhelm Borchers**, Aix-la-Chapelle, Germany. Filed April 25, 1899. Issued June 19, 1900.

A high-temperature smelting furnace having two opposite, vertical fuel-shafts serving alternately as combustion and heat-accumulator chambers, a horizontal passage connecting the lower ends of said fuel-shafts, a vertical smelting-shaft arranged centrally between the fuel-shafts and opening at its lower end into said horizontal connecting-passage, holes in the sides of the fuel-shafts for lighting the fuel therein and discharging the ashes therefrom, plugs for closing said openings, pivotally mounted bails, presser-rods pivoted to said bails for holding said plugs in position, air injector nozzles entering the lower portions of the fuel-shafts opposite said horizontal passage, valved devices for feeding the fuel into, and closing the upper ends of said fuel-shafts, a gas-escape pipe independent of said nozzles arranged in rear of the fuel-shafts and having branch pipes connected respectively with the top portion of said fuel-shafts, and a valve for controlling communication of either branch pipe with the gas-escape pipe, substantially as described.

- 991 654,066. Retort-furnace.—**Robert E. Lauck**, Kansas City, Mo. Filed Feb. 27, 1899. Issued July 17, 1900.

In a retort-furnace, a retort having its front end projecting through the furnace-wall, and comprising a casing having an inlet port near one end and an outlet-port at the other, and provided with an internal comb, a perforated partition at the front end of the comb and furnace, a non-conductor of heat filling the casing forward of the partition and a shaft journaled in the casing and extending through the partition, and provided with a skeleton spiral conveyor, the teeth of which pass between those of the comb, substantially as described.

- 991a 656,268. Process of treating ores for recovery of metallic ingredients.—**Benjamin Sadtler**, Denver, Colo., assignor to Albert G. Clark, Cincinnati, Ohio. Filed July 13, 1899. Issued Aug. 21, 1900.

The improvement in the process of treating ores; wherein zinc is combined with iron or other agents which attack fire-clay, consisting in distilling such ores in a retort wherein chemical reactions between the ingredients of the ores and of the retort are excluded, and thereafter treating the residue from such distillation for the extraction of metallic ingredients.

- 992 665,774. Process for treating sulphide ores.—**Hugh F. Kirkpatrick-Pickard**, London. Filed June 28, 1900. Issued Jan. 8, 1901.

Consists in roasting the ore to the form of oxides, mixing the roasted product with carbonaceous material suitable for coking, forming the mixture into briquettes, and distilling the briquettes under such conditions that they are first coked into coherent masses and finally the zinc is reduced and volatilized while the lead is reduced and the lead and silver retained in minute particles throughout the coke.

- 993 666,597. Apparatus for treating zinc ores.—**Samuel G. Bridges**, Kansas City, Mo. Filed Nov. 5, 1900. Issued Jan. 22, 1901.

A fume arrester, comprising a pump, a pipe for conveying fumes to the pump, and provided with a water supply and baffle plates, a trap in advance of the pump inlet to prevent the admission of solid matter to the pump, a condensing tank and a vertically disposed pipe leading from the pump into the condensing tank.

- 994 669,410. Art of extracting zinc from ores.—**Franklin Guiterman**, Denver. Filed Feb. 14, 1900. Issued March 5, 1901.

The process of extracting zinc from its oxidized ores containing corrosive metallic oxides, which consists in introducing the oxidized ore in a divided or granular condition into a receptacle, heating the ore through the walls of said receptacle, to a high temperature, but below the volatilizing temperature of zinc, maintaining the ore in a permeable and mobile condition during the operation of heating, introducing into intimate contact with said ore a current of reducing-gas, under pressure, throughout the heating, continuing the heating and the action of the reducing-gas until the corrosive metallic oxides are reduced as described, withdrawing the ore and finally recovering the metallic zinc therefrom by distillation.

- 995 669,411. Retort for treating ores.—**Franklin Guiterman**, Denver, Colo. Filed Feb. 21, 1900. Issued March 5, 1901. 7 claims.

- 996 669,750. Method of making zinc-white.—**David B. Jones**, Chicago, Illinois. Filed July 14, 1900. Issued March 12, 1901.

Consists in imparting a cyclonic swirl to a mixed charge of powdered ore, fuel and flux by projection it tangent'ally in divided masses through aid of an air blast into the furnace, setting the charge aflame, expanding the resultant pigment fumes and combustion products freely upward toward the exit and simultaneously separating and trapping the associated non-volatile constituents or slags by arrest thereof during the centrifugal swirl.

- 997 674,936. Furnace for the reduction of zinc ores.—**Harrison B. Meech**, Denver, Colo. Filed Sept. 26, 1900. Issued May 28, 1901.

- 998 681,609. Process of treating zinc-bearing complex ores.—**Guy de Bechi**, Paris, France. Filed Mar. 19, 1900. Issued August 27, 1901.

A process for the treatment of zinc-bearing complex ore containing zinc, copper, lead, and silver, which consists in pulverizing said ore, mixing the pulverized ore with binding material and a chloride salt of an alkali or an alkaline-earth metal, compressing said mixture into blocks, roasting said blocks, and finally introducing a reducing agent and smelting the blocks, the entire process being carried out in one operation at such a temperature that fumes of chlorides and oxides of zinc and copper are evolved and that metallic lead and silver are recovered, and condensing the said fumes.

- 999 686,915. Treatment of zinc ores.—**Henri M. Taquet**, Argenteuil, France. Filed Mar. 29, 1901. Issued November 19, 1901.

The herein-described process which consists in first subjecting a solution containing sulphate and chloride of zinc to the action of oxide of an alkaline-earth metal and thereby obtaining by precipitation an artificial product composed of oxide of zinc and sulphate of the alkaline-earth metal and then subjecting this product mixed with carbon to heat and thereby obtaining at one and the same operation metallic zinc and a residue of alkaline-earth-metal sulphide.

- 1000 692,148. Process of recovering zinc from sulphide ores.—**Hugh F. Kirkpatrick-Picard**, London, England. Filed July 9, 1901. Issued January 28, 1902.

The process of treating sulphide ores containing zinc and other metals, which consists in mixing the unroasted ores with a basic material capable of combining with sulphur, and carbonaceous material suitable for coking, forming the material into briquets and distilling the briquets under such conditions that they are first coked into coherent masses and finally the zinc is reduced and volatilized while the resulting sulphide and the non-volatile metals are retained in minute particles throughout the coke. Patented also in England, No. 2151 of 1900.

- 1001 694,137. Zinc-furnace.—**George G. Convers** and **Arthur B. DeSaulles**, South Bethlehem, Pa. Filed September 14, 1898. Issued February 25, 1902.

- 1001 694,947. Process of smelting zinc.—**Samuel Davis**, Iola, Kansas. Filed June 5, 1900. Issued March 11, 1902.

The process of smelting zinc, consisting in placing a mixture of zinc oxide and particles of non-metallic refractory substances within a retort, exteriorly heating the latter, passing a current of hydrocarbon gas through the charge, whereby reduction is effected, conducting the gas and the vaporized metal carried thereby through a condenser to deposit the metallic zinc and finally permitting the gas to escape.

- 1003 695,376. Production of zinc-dust.—**George G. Convers** and **Arthur B. DeSaulles**, South Bethlehem, Pa. Filed September 14, 1898. Issued March 11, 1902.

The process of obtaining the substantially maximum yield of zinc-dust or blue powder from a given retort charge, which consists in preliminarily heating the charge to effect the distillation of zinc, receiving the metallic zinc vapors given off from the charge, in their substantial entirety from the muffle into a collecting chamber, thereby maintaining their temperature throughout above the point of liquifaction of any substantial portion of the vapor until they have entered the collecting chamber, and immediately condensing them in said chamber under such conditions of temperature and expansion as will precipitate them in substantially their entirety in the form of zinc dust.

- 1004 698,163. Process of refining spelter.—**Charles Wessell**, New York, N. Y. Filed April 29, 1901. Issued April 22, 1902.

The process of refining spelter which consists in treating the refined spelter with phosphorous, or with phosphorous and magnesium. Patented also in England, No. 22,387 of 1901.

- 1005 699,969. Process of making spelter.—**Oskar Nagel**. New York, N. Y. Filed Nov. 13, 1901. Issued May 13, 1902.

An improved process for condensing zinc vapors to spelter which consists in cooling the vapors in an atmosphere of water-gas. Patented also in England, No. 10,953 of 1902.

- 1006 700,311. Treatment of complex and refractory ores.—**Francis Ellershausen**, London, England, assignor to the Sulphides Reduction (New Process), Ltd., London. Filed Feb. 15, 1900. Issued May 20, 1902.

The process of treating complex and refractory ores containing lead, silver and zinc which consists in smelting the raw ores, positively drawing off the fumes and gases, and churning them with water to condense and mix them therewith, settling out the lead, silver and part of the zinc compounds from the resulting liquor, as a sludge, separating and drying the sludge, mixing black ash with burnt lime and passing water therethrough and evaporating the resulting liquid to obtain a molten crude caustic alkali, fusing the dried sludge, with said molten crude caustic alkali, thereby precipitating the lead in metallic form, separating the lead and treating the residual molten mass with water to dissolve out the caustic soda and precipitate sulphide of zinc, treating the liquid from which the sludge was separated and which contains the zinc sulphate with the caustic soda, thereby precipitating the zinc and converting the caustic soda into sulphate of sodium and recovering the sulphate of sodium. Patented also in England, No. 483 of 1900.

- 1007 701,457. Apparatus for obtaining zinc or other volatile metals from ores or mattes.—**John Armstrong**, London, England. Filed Aug. 30, 1900. Issued June 3, 1902. 6 claims.

- 1008 702,526. Spelter furnace.—**Alfred Ash**, Peterswood, England. Issued June 17, 1902.

A reverberatory furnace for refined hard spelter, having an inclined liquation bed, with refining and collecting pits adjacent to the lower edge.

- 1009 701,458. Process of obtaining zinc or other volatile metals from ores or mattes.—**John Armstrong**, London, England. Filed August 30, 1900. Issued June 3, 1902.

The process of smelting compounds of volatile metals, which consists in heating them with carbon out of contact of air, reducing and vaporizing them in a reducing atmosphere consisting largely of carbon monoxide, and condensing them by passing the metallic vapors and the carbon monoxide into a bath of the same metal that is being condensed, which bath is maintained in a molten state, but not much above the melting-point, condensing the metal in said bath and passing the carbonic oxide through the same. 5 claims. See also U. S. Pat. 713,043, Nov. 4, 1902.

- 1010 701,885. Retort.—**Evan H. Hopkins**, South Kensington, England. Filed Oct. 18, 1901. Issued June 10, 1902. Patented in England, no. 22,554 of 1900.

- 1011 702,764. Process of extracting zinc.—**Jules L. Babe** and **Alexis Tricart**, Paris, France. Filed June 29, 1900. Issued June 17, 1902.

The process of extracting metallic zinc from ores poor in zinc, which consists in forming briquets from a mixture of the ore, carbonate of soda and carbon, subjecting said briquets to the action of heat suitable for driving off the zinc-vapors from said briquets, condensing the said vapors driven off, whereby a condensation product containing zinc oxide is formed, mixing said product with carbonate of soda and carbon, subjecting said mixture to a suitable temperature for driving off the metallic zinc in the form of vapors, and condensing said vapors.

- 1012 701,601. Smelting-furnace.—**Charles Laughlin**, St. Louis, Mo. Filed April 11, 1901. Issued August 26, 1902.

- 1013 707,602. Smelting furnace.—**Charles Laughlin**, St. Louis, Mo. Filed Dec. 28, 1901. Issued August 26, 1902.

- 1014 708,044. Process of obtaining zinc.—**Evan H. Hopkins**, South Kensington, England. Filed July 1, 1901. Issued September 2, 1902.

The process of obtaining zinc free from lead, from the mixtures of the oxides of zinc and lead which consists in heating carbon to incandescence, heating the oxides mixed with carbonaceous materials in a closed retort and passing the products of distillation upward through the incandescent carbon. Patented also in England, No. 708,044, of 1900; France, 325,903, Oct. 25, 1902.

- 1015 708,438. Zinc-furnace.—**William C. Wetherill**, Joplin, Mo. Filed Oct. 12, 1900. Issued September 2, 1902. 12 claims.

- 1016 710,217. Furnace for separating zinc from ores.—**Amedee M. G. Sebillot**, Paris, France. Issued Sept. 30, 1902.

In a furnace for extracting zinc from ores, a combustion-chamber divided into front and rear compartments adapted to hold the ores

to be treated, and charcoal, respectively, air-blast pipes communicating with the front compartment, said compartments connected by openings in their division-wall, and condensing-chambers connected by suitable openings with the upper and lower portions of said compartment of the furnace.

- 1017 713,043. Process of smelting and refining volatile metals.—**John Armstrong**, London, England. Filed March 24, 1902. Issued November 4, 1902.

The process which consists in smelting ores containing zinc and like volatile metals and other less volatile metals with fluxes, so as to slag the more volatile metals, condensing any fumes in the form of poussiere, returning the same to the furnace, drawing off the slag and distilling it with fuel to obtain the zinc and other very volatile metals and tapping out the mixture of lead, silver and other like metals.

- 1018 714,502. Process of extracting zinc from zinc-skimmings.—**Herman C. Meister**, St. Louis, Mo. Filed Aug. 16, 1902. Issued Nov. 25, 1902.

A process of converting zinc compounds of zinc skimmings into oxide of zinc, which consists in treating the zinc skimmings with the oxide of an alkali or the oxide of an alkaline earth in the presence of moisture.

- 1019 714,503. Process of extracting zinc from zinc-skimmings.—**Hermann C. Meister**, St. Louis, Mo. Filed Aug. 16, 1902. Issued Nov. 25, 1902.

A process of converting zinc compounds of zinc skimmings into carbonate of zinc which consists in treating the zinc-skimmings with the carbonate of an alkali in the presence of moisture.

- 1020 714,615. Furnace.—**Erminio Ferraris**, Monteponi, Sardinia, Italy, assignor of one-fourth to W. R. Ingalls, Lynn, Mass. Filed Aug. 16, 1901. Issued Dec. 2, 1902.

- 1021 715,024. Extracting metals from complex or sulphide ores.—**John C. Clancy** and **Luke W. Marsland**, Sydney, New South Wales. Filed Mar. 2, 1901. Issued Dec. 2, 1902.

A process of extracting and recovering gold, silver, lead, zinc, and other metals from mixed or complex sulphide ores consisting essentially in the following successive operations; heating the ore with the addition or admixture of lead sulphate in a cupola or blast-furnace so as to convert the required amount of lead and the whole of the zinc and other volatile metals contained in said mixture more or less wholly into fume, spraying dilute sulphuric acid upon the fume and gaseous products of decomposition to convert the fumed metallic oxides into their corresponding sulphates, recovering the lead sulphate used for mixing with the ore and the zinc and other volatile metals from the sulphates deposited in the first-named or fume chamber, recovering the metallic contents from the residue remaining in the furnace by smelting. Patented also in England, No. 9,503 of 1901.

- 1022 715,238.** Process of refining lead and zinc fumes.—**Frank L. Bartlett**, Canon City, Colo. Filed Mar. 25, 1901. Issued Dec. 9, 1902.

Consists in subjecting a collected mass or body of the fume to the action of heated carbonic-dioxide gas.

- 1023 717,299.** Extraction of zinc and lead from sulphide ores.—**George C. Stone**, Newark, N. J. Filed May 24, 1899. Issued December 30, 1902.

The method of separating zinc and lead from sulphide ores, which consists in smelting the sulphides, oxidizing the volatile constituents at their exit from the smelting furnace, cooling the resulting fumes and products of combustion to a temperature not exceeding 180° Fahrenheit and passing them into contact with a solvent which will dissolve out one of the metals and not the other, collecting the resulting solution and enriching and concentrating it by passing it into further contact with the fume-current. 3 claims.

- 1024 718,222.** Process of reducing zinc from its oxides.—**Wilhelm Schulte**. Overpelt-lez-Neerpelt, near Limburg, Belgium. Filed April 22, 1902. Issued January 13, 1903.

A process for smelting oxidized zinc ores which consists in impregnating the ore with hydrocarbons, mixing it with a quantity of coal less than necessary for effecting alone a reduction of the ore, and then distilling the mixture. Patented also in France, No. 318,265.

- 1025 720,664.** Zinc-smelting furnace.—**Joseph P. Cappeau**, Joplin, Mo. Filed Oct. 22, 1902. Issued February 17, 1903.

The combination with a zinc-smelting furnace, of a series of air-pipes arranged at intervals at the front of the furnace, a main air passage adjacent to the lower ends of the air-pipes, communicating with them and open at its end to the outer air, and discharge ports in the air-pipes communicating with the interior of the furnace, adjacent to the retorts, whereby air is conveyed to the furnace by a natural draft and distributed at numerous intervals to the furnace adjacent to the retorts. 5 claims.

- 1026 727,297.** Apparatus for producing zinc-dust.—**George G. Convers** and **Arthur B. De Saulles**, South Bethlehem, Pa. Filed September 14, 1898. Issued May 5, 1903.

An apparatus for the recovery of zinc dust or blue powder, comprising a plurality of muffles arranged at different heights, a furnace for heating the same externally, and an expansion-chamber, common to the series, the rear wall of the expansion chamber being formed by the front wall of the combustion chamber, thereby providing direct and jointless communication between the muffles and expansion-chamber, said expansion-chamber being of such capacity relatively to the retorts as to immediately expand and solidify the zinc-vapors into zinc-dust.

- 1027 727,298.** Apparatus for producing zinc-dust.—**George G. Convers** and **Arthur B. De Saulles**, South Bethlehem, Pa. Filed September 14, 1898. Issued May 5, 1903.

Apparatus for the recovery of zinc-dust or blue powder, comprising a zinc-distilling muffle, a furnace for heating the same ex-

ternally, and a collecting and expansion chamber immediately adjacent to the muffle and of such relative size and capacity as to be kept heated by the zinc vapors and to precipitate the said vapors therein in their substantial entirety as zinc-dust.

- 1028 731,184. Process of obtaining zinc.—**Evan H. Hopkins**, London, England. Filed June 16, 1902. Issued June 16, 1903.

The process of reducing and collecting zinc which consists in subjecting a material which contains zinc to heat in the presence of a reducing agent, excluding air and the heating flame therefrom, and in conveying the zinc-vapors into and condensing all of them in a mass of carbon from which air is excluded and which is heated to a temperature between those at which zinc solidifies and volatilizes. 5 claims. Patented also in England, No. 12,859, of 1902.

- 1029 735,894. Treatment of zinc or other ores.—**William B. Middleton**, London, England. Filed Dec. 27, 1901. Issued August 11, 1903.

In the treatment of zinc-ores to produce zinc-white, the process which consists in heating the ore, transferring the said ore in a layer onto the top of the fuel previously ignited till it burns clear, reducing it directly in contact with such fuel, adding a fresh layer of fuel when the ore is spent, heating a fresh quantity of ore and transferring it to the fresh fuel and so on. Patented also in England, No. 12,274, of 1901.

- 1030 735,902. Method of treating zinc ores.—**Carl V. Petracus**, Iola, Kansas. Filed Nov. 19, 1901. Issued Aug. 11, 1903.

The method of treating zinc ores for the economic utilization of their metallic contents, which consists in mixing said ores with carbon, subjecting the mixture to high heat with exclusion of air to smelt and volatilize the greater portion of the zinc, recovering the volatilized zinc by condensation, subjecting the unvolatilized residue, consisting of coke and ore, to heat in an oxidizing atmosphere to oxidize the zinc, and any lead therein, and drive them off as a fume, recovering said fume by screening the furnace gases, and finally subjecting the recovered fume to a temperature indicated by a red heat, to whiten it.

- 1031 735,903. Method of manufacturing spelter from zinc ores.—**Oliver H. Picher**, Joplin, Missouri. Filed Aug. 26, 1899. Issued Aug. 11, 1903.

The method of manufacturing spelter from zinc ore containing lead and iron pyrites which consists first in eliminating the lead contents of the ore by heating it in contact with air to a temperature sufficient to sublime the lead, but below that at which zinc is sublimed in material quantity, then desulphurizing the residue and rendering the pyrites porous by calcination, then separating the altered pyrites from the desulphurized residue and finally treating the residue in admixture with carbon retorts to volatilize the zinc.

- 1032 736,008. Treatment of zinc ores.—**Carl V. Petracus**, Iola, Kansas. Filed Nov. 19, 1901. Issued August 11, 1903.

The method of treating zinc ores which consists in mixing such ores with carbon, subjecting the mixture to high heat with exclusion

of air, in order to reduce and distil a large portion of the zinc, condensing the distilled metal, recovering the zinc fumes which escape from the distilling and condensing apparatus, mixing said fumes with the carbonaceous and metal-bearing residue of the distilling process, treating said mixture to reduce and oxidize the metals in order to drive off its metallic contents as a fume, and recovering said fume by screening the furnace gases.

- 1033 736,009. Treatment of ores containing zinc or other metals.—**Carl V. Petraeus**, Iola, Kansas. Filed Nov. 19, 1901. Issued August 11, 1903.

The method of treating zinc ores containing other valuable metals, which consists in mixing said ores with carbonaceous material, smelting and volatilizing a large portion of the zinc by heating the mixture with exclusion of air, recovering the volatilized zinc by condensation, treating the metal-bearing residue of the distillation process in admixture with carbon to drive off the zinc as an oxide fume and, at the same time, cinder together the residue containing the other valuable metals, by heating the mixture to a sufficient temperature in an oxidizing atmosphere, and then smelting said cindered residue, to recover its contained metals.

- 1034 736,010. Method of smelting zinc oxide.—**Carl V. Petraeus**, Iola, Kansas. Filed Nov. 19, 1901. Issued August 11, 1903.

The method of making zinc from sublimated zinc oxide which consists in first heating the oxide to a red heat to eliminate sulphur and condense the zinc oxide then intimately mixing the densified oxide with carbon and wetting the mass prior to charging it into the retorts, and finally smelting the mixture in retort furnaces.

- 1035 742,830. Metallurgical process.—**Oliver W. Brown**, Bloomington, and **William F. Oesterle**, Marion, Ind. Filed May 14, 1903. Issued November 3, 1903.

The process of simultaneously producing metallic zinc and a carbide, which consists in mixing with the zinc ore, carbon and an oxide of a metal having a greater affinity for carbon than for the zinc and then heating the mixture to a temperature sufficient to produce the products.

- 1036 751,401. Method of treating refractory ores.—**Edward H. Miller**, London, England. Filed November 27, 1903. Issued Feb. 2, 1904.

The process for the treatment of refractory lead-zinc ores consisting in mixing the ore with silicious matter and pitch, with the addition of lime according to the silver value of the ore, forming the mixture into dry blocks, packing the dry blocks into a furnace with suitable air spaces, and sprinkling the layers with lime and gradually raising the temperature, whereby substantially the whole zinc content of the ore is converted into metallic zinc which distills over, and the lead and silver contents of the ore are also converted into the metallic state in which state they are retained in the residue in the retort and recovered therefrom by melting out. Patented also in England, No. 20,465, of 1902.

- 1037 754,141. Process of obtaining zinc.—**Evan H. Hopkins**, South Kensington, London, England. Filed June 4, 1903. Issued March 8, 1904. Patented also in England, No. 12,859 of 1902.

Improvement on U. S. Patent 731,184.

- 1038 757,059. Furnace for producing zinc.—**Paul Schmieder**, Lipine, Germany. Filed October 29, 1902. Issued April 12, 1904.

In a furnace for extracting zinc, the combination of a vertical receptacle or shaft for the charge of ore mixed with fuel, with a device for heating the upper part of the charge through the walls of said receptacle, a number of condensers or collectors of the liquid zinc for this reduction-chamber, a number of tuyers in the lower part of the shaft which is not arranged to be heated, an oxidation-chamber, a condensing chamber and openings above the tuyers and suitable channels for leading the gases from this oxidation-chamber for the slag to the condensing-chamber.

- 1039 766,279. Process of making spelter.—**Oskar Nagel**, Ham-born, Germany. Filed Jan. 12, 1903. Issued August 2, 1904.

An improved process for making spelter from zinc oxidic ores, which consists in subjecting the material to the reducing effect of gaseous or gasified hydrocarbons heated previously to entrance in the reducing chamber, and in cooling the resulting zinc vapors in an atmosphere of such gas.

- 1040 775,359. Apparatus for the extraction of zinc.—**Charles S. Brand**, Knowle, England. Filed Feb. 6, 1904. Issued Nov. 22, 1904.

The combination with means for the extraction of zinc, of the condensing-chamber, the passage connecting the means for extraction of zinc with the condensing-chamber and a mass of chemically-inert and refractory or non-combustible material in said passage. Patented also in England, No. 263 of 1904; in France, No. 341,345.

- 1041 775,360. Apparatus for the extraction of zinc.—**Charles S. Brand**, Knowle, Eng. Filed Feb. 6, 1904. Issued Nov. 22, 1904.

In the extraction of zinc, the combination consisting of a retort, or detachable nozzle or condensing-pipe having a free space in its interior, or an internal bridge or baffle-piece projecting from the under side of the said pipe toward the upper side of the same and dividing the pipe interior into fore and aft areas or chambers communicating only at their upper sides, a rearwardly inclined lower surface in the aft area or chamber, a perforated closure at the rear end of the pipe and a detachable partial closure at the forward end of the same. Patented also in England, No. 3,628 of 1904; in France, No. 341,346.

- 1042 792,773. Regenerative retort-furnace.—**Herman Hegeler and Julius W. Hegeler**, Lasalle, Ill. Filed Dec. 12, 1903. Issued June 20, 1905.

In a regenerative retort-furnace of the class described, the combination with the two-compartment retort-chamber, the compartments communicating at the top, of regenerators located beneath each of said compartments, a series of flues connecting a regenerator with each compartment of the retort-chamber and communicating with the space therein below the lowermost tier of retorts only, and another series of flues connecting a regenerator with each compartment of the retort-chamber and having several ports at different heights and communicating with the spaces beneath the lower and other tiers of retorts. 8 claims.

- 1043 794,799. Zinc-smelting furnace.—**Edward C. Hegeler**, La-salle, Ill. Filed Feb. 2, 1903. Issued July 18, 1905.

In a zinc-smelting furnace of the class specified, a long, horizontal retort chamber through which the gases pass unobstructed, except by the retorts, in the direction of its greatest extension, having staggered recesses in its roof and its bottom and in combination with the retorts arranged in the space outside the recesses and separated into groups by open vertical spaces, the recesses in the roof and bottom being arranged alternately over and under the space occupied by a group of retorts and the pair of open vertical spaces adjacent thereto.

—Described. Jour. Soc. Chem. Ind. vol. 24, pp. 1175-76. Nov. 30, 1905.

- 1044 806,121. Zinc furnace.—**Emile Dor-Delattre**, Budel, Netherlands. Filed Apr. 12, 1905. Issued Dec. 5, 1905.

A gas heated zinc furnace having independent air and gas channels, and a chamber adapted to support a series of retorts, the roof of the chamber having formed therein a plurality of narrow apertures each communicating with both said air and gas channels, said apertures being each arranged in line with a retort in said chamber, and a plurality of retorts being arranged in each of the spaces between said apertures. 5 claims. Patented also in France, No. 358,150; in England, No. 19,655 of 1905.

- 1045 807,271. Process of extracting metals from their sulphides.—**Antoine M. Imbert**, Grand-Montrouge, France. Filed Dec. 22, 1903. Issued December 12, 1905.

The process of extracting zinc and lead from a complex ore containing blende and galena, consisting in adding to the ore the necessary copper and fluxes; in heating the mixture to the vaporization temperature of zinc, but maintaining the lead at a temperature below the vaporizing point of this latter metal in condensing the vaporized zinc and drawing off the molten lead; in separating the resulting scoriae and copper sulphide; and in recovering the copper from the sulphide in order that it may be used over again.

- 1046 812,619. Method of preserving the inner walls of furnaces.—**Friederich C. W. Timm**, Hamburg, Germany. Filed Apr. 21, 1905. Issued Feb. 13, 1906.

- 1047 813,021. Method of charging retorts, muffles, furnaces and the like.—**Augustin L. J. Queneau**, South Bethlehem, Pa. Filed Jan. 16, 1905. Issued February 20, 1906.

1048 813,022. Charging-machine.—**Augustin L. J. Queneau**, South Bethlehem, Pa. Filed Jan. 16, 1905. Issued Feb. 20, 1906.

1048a 813,023. Apparatus for charging retort-benches.—**Augustin L. J. Queneau**. Filed Jan. 16, 1905. Issued Feb. 20, 1906.

1049 826,557. Process of reducing metals.—**George L. Fogler**, Pittsburg, Pa. Filed Aug. 19, 1904. Issued July 24, 1906.

The continuous process of smelting ores which consists in forcing previously heated reducing gases into a reducing-zone maintained in the ore, furnishing a supply of air insufficient to effect complete combustion around the gas-supply whereby the incompletely burning gases reduce the ores, maintaining a partial vacuum above the charge whereby the gaseous products of the incomplete combustion and of the reduction expand into the upper portion of the charge and rapidly leave the reduction zone; continuously maintaining the reducing atmosphere in the furnace, drawing off the products of the smelting process and supplying fresh ore and flux from time to time.

1050 826,568. Flux for extracting metals from ores.—**Adolf Gutensohn**, Southend, England. Filed Nov. 3, 1905. Issued July 24, 1906.

A flux for the purposes stated, consisting of the admixture of borate of manganese with carbon and slag-liquefying material, consisting of fluorspar.

1051 827,418. Process of refining zinc and other metals.—**Jacob Callmann and Rudolf Bormann**, Berlin, Germany. Filed Feb. 15, 1906. Issued July 31, 1906.

The continuous process of refining zinc and other metals, which consists in melting the metal passing it in a molten condition and in a thin stream or layer through a suitable conduit, and subjecting it to a gradually-increasing heat in said conduit, until the boiling temperature thereof is reached. Patented also in England, No. 3,252 of 1906; in France, No. 362,802. See also item 752.

1052 830,283. Apparatus for obtaining zinc.—**John Armstrong**, London, England. Filed Sept. 20, 1905. Issued Sep. 4, 1906.

In an apparatus for obtaining zinc a high narrow reducing-chamber with means for feeding the same at top and at the same time sealing it from the air, means for discharging it at the bottom with air seal, the said chamber being made slightly tapered so as to be wider at the bottom than at the top and extending in depth and height beyond the heating-flues whereby the material easily ascends and is cooler at the top and bottom than at the intermediate zone of reduction. 10 claims. Patented also in England, No. 20,543 of 1905.

1052a 831,165. Roasting furnace.—**Frank Klepetko**, New York. Filed Nov. 6, 1905. Issued Sept. 18, 1905.

1053 833,472. Process of obtaining metals and compounds thereof.—**Herman Mehner**, Berlin, Germany. Filed February 18, 1904. Issued October 16, 1906.

The process which consists in bringing zinc ore in contact with carbon and an incandescent fluid heat carrier, leading off the zinc vapors and gases generated for condensation and separation. 11 claims.

- 1054 837,446. Means for carrying off gases from retorts while being charged.—**Martin Ziegler**, Beuerberg, Tsartalbah, Germany, assignor to Oberbayrische Kokswerke und Fabrikchemischer Produkte Aktien-Gesellschaft, Munich, Germany. Filed Aug. 1, 1906. Issued December 4, 1906.

- 1055 839,160. Zinc-smelting furnace.—**William Lanyon**, Iola, Kans. Filed July 31, 1906. Issued Dec. 25, 1906.

A zinc furnace constructed with a center wall in which is formed a flue, means whereby air and gas are delivered into the ends of said furnace, and means whereby the air and gas during combustion are caused to pass upward between the retorts in the ends of the furnace, downward between the retorts in the center of the furnace, and thence outward through the flue in the center wall. 12 claims.

- 1056 834,872. Furnace for obtaining zinc from zinc ores.—**Adolphe Desgraz** and **Paul Schmidt**, Hanover, Germany. Filed Sept. 13, 1906. Issued Feb. 12, 1907. Patented also in France, no. 367,368.

- 1057 851,187. Process of treating zinc and lead ores.—**John Thelberg**, New York, N. Y. Filed July 16, 1902. Issued April 23, 1907.

The process of treating virgin ores containing zinc sulphide or lead sulphide or both for the purpose of producing oxide of zinc, sulphates of zinc and lead and sulphuric acid, which consists in forcing a superheated mixture of steam and air into a body of such ore in a furnace, which ignites and oxidizes the sulphur, zinc and lead, then conveying the volatilized sulphates and oxides, together with the gases out of the furnace, cooling the gases, the volatilized oxide and sulphates to a suitable temperature, separating the condensed zinc oxide and zinc and lead sulphates from the gases, and finally conveying the separated gases, consisting of sulphur dioxide and nitrogen, into any suitable apparatus for the conversion of the sulphur dioxide into sulphuric acid. Patented also in England, No. 2,789 of 1907.

- 1058 851,668. Process of filling zinc-retorts.—**John D. James**, Pulaski, Va. Original application filed Jan. 3, 1906. Divided and this application filed Nov. 12, 1906. Issued Apr. 30, 1907.

- 1059 852,440. Process of reducing zinc ores.—**G. P. de Laval**, Stockholm, Sweden, assignor to Société Anonyme Métallurgique Procédés de Laval, Frankfurt on-the-Main, Germany, a Corporation of Belgium. Filed July 15, 1905. Issued May 7, 1907.

The process of reducing zinc ores which consists in subjecting a pulverous charge containing the zinc ore mixed with material necessary for carrying out the chemical reactions in a suitable furnace to a rapid rotating or whirling motion produced by means of a current of gas. Patented also in France, No. 356,097.

- 1060** 870,668. Process of desulphurizing and reducing sulphide ores.—**Eduard Dedolph**, Marysville, British Columbia, Canada. Filed Mar. 23, 1907. Issued Nov. 12, 1907.

The process of desulphurizing and reducing sulphide ores, which consists in roasting the ground ore intimately mixed with finely divided carbonaceous fuel, in such fashion as to oxidize the sulphur and a portion only of the fuel, and then smelting the product consisting of the roasted ore and the unconsumed fuel.

- 1061** 875,578. Process of treating zinc and lead sulphide ores.—**Antoine H. Imbert**, Grand-Montrouge, France. Filed Nov. 9, 1906. Issued Dec. 31, 1907.

Consists in heating the sulphide in the presence of an oxide of such a character as to form a dissolvent for the said metallic sulphides with a metal having a greater affinity for sulphur than the metal of the sulphide. 11 claims. Patented also in England, No. 10,303 of 1906.

- 1062** 875,579. Metallurgical treatment of sulphurous ores by the precipitation process.—**Antoine H. Imbert**. Grand-Montrouge, France. assignor to Imbert Process Co., New York, N. Y.. Filed June 6, 1907. Issued Dec. 31, 1907.

Consists in heating the sulphide in the presence of an oxide and a sulphide of such a character that they will form a dissolvent for the said metallic sulphides with a metal having a greater affinity for sulphur than the metal of the sulphide being reduced. 15 claims. Patented also in England, No. 10,303 of 1906.

- 1063** 875,580. Metallurgical method of treating oxidized zinc ores (calamines, oxides, silicates) by the precipitation process.—**Antoine H. Imbert**, Grand-Montrouge, France, assignor to Imbert Process Co., New York, N. Y. Filed June 6, 1907. Issued Dec. 31, 1907.

The process of extracting zinc from oxide ores, which consists in heating the ore in the presence of a metallic oxide, a metallic sulphide of such a character as to form a dissolvent for said ores and a metallic reagent having a greater affinity for the element with which the zinc is combined than has the zinc. Patented also in England, No. 10,303 of 1906.

- 1064** 876,275. Smelting furnace with oil fire.—**August Koch**, Hanover-List, Germany. Filed June 27, 1906. Issued Jan. 7, 1908.

In a furnace of the character described, the combination of a plurality of chambers adapted to be alternately used for melting and preheating, oil vaporizing and air heating chambers located between said melting chambers, so that the heat radiated by the melting chambers will vaporize the oil and preheat the air in said air and oil chambers.

- 1065 877,114. Method of obtaining oxide fumes from ores and furnace products.—**Hermann Pape**, Hamburg, Germany. Filed Dec. 31, 1906. Issued January 21, 1908.

A method of obtaining oxide fumes from ores or furnace products, consisting in finely disintegrating said ore or furnace products, in mixing finely disintegrated carboniferous reducing means therewith, in making briquets of the mixture thus obtained, in feeding said briquets continuously into a furnace, in burning the carbon contained in said briquets in said furnace, in continuously supplying a powerful current of air to said burning briquets, whereby the volatile metals contained in said ore or furnace products are first reduced and then burned to oxides in the excess oxygen of the current of air, in continuously withdrawing said oxides with the furnace gases and in continuously removing the non-volatile residue of said briquets in a liquid state from the furnace.

- 1066 879,482. Metallurgy of zinc.—**Franz Meyer**, Engelwood, N. J., assignor to Metallurgical Company of America, New York, N. Y. Filed Jan. 13, 1906. Issued Feb. 18, 1908.

The method of treating ore or the like in an internally heated furnace, which consists in feeding the charge containing the ore in an upward direction through the active zone or zones of the furnace, progressively supplying from below fresh portions of the charge, causing the air necessary for combustion to traverse the active zone or zones in a downward direction, withdrawing the products of combustion and reaction laterally from the moving charge, condensing out any distilled or vaporized metal contained in said products, at their point of issuance from the charge, and maintaining the temperature of the condensed metal above its melting point so as to permit its collection in a liquid state. 7 claims.

- 1067 879,483. Metallurgical furnace.—**Frank Meyer**, Englewood, N. J., assignor to Metallurgical Company of America, New York, N. Y. Filed Jan. 13, 1906. Issued Feb. 18, 1908.

- 1068 881,355. Process of treating zinc-retort residues.—**Gustav Stolzenwald**, Valea Calugareasca, Roumania. Filed Sept. 22, 1906. Issued March 10, 1908.

A process of utilizing waste products of zinc works consisting in mixing material containing zinc with the residue from zinc distillation works and heating said mixture in a continuous acting furnace whereby the use of coal and coke is rendered unnecessary. Patented also in England, No. 18,134 of 1906; in France, No. 368,458.

- 1069 893,415. Process of refining zinc.—**Richard Ziesing**, Cleveland, Ohio. Filed Feb. 27, 1907. Issued July 14, 1908.

The process of refining zinc from an alloy containing lead, which consists in directing heat from above against the receptacle containing the zinc-lead alloy, sufficient to maintain the body of metal in a freely molten or fluid condition and meanwhile insure surface distillation of the zinc, whereby the lead settles to the bottom of the receptacle and the zinc is vaporized, and shielding the lower portion of the receptacle containing the lead, from heat.

1070 893,560. Apparatus for refining zinc.—**Richard Ziesing**, Cleveland, Ohio. Filed Feb. 27, 1907. Issued July 14, 1908.

1071 894,383. Treatment of ores by means of the precipitation process.—**Antoine H. Imbert**, Grand-Montrouge, France, assignor to Imbert Process Company, New York, N. Y. Filed Aug. 19, 1907. Issued July 28, 1908.

The smelting of zinc ores by the precipitation process, consisting in introducing into a hermetically closed chamber a continuous current of liquid superheated metal of a character capable of replacing the metal of the ore which it is desired to extract, introducing a charge of crushed ore and dissolvents in the form of a stream, causing the two streams to meet and allowing them to flow along in contact until the zinc be exhausted, collecting separately the zinc vapors and gaseous products in condensing the zinc, causing the excess of metal to escape separately and in causing it to return to the superheater and then to the reacting chamber, causing the residue of the reaction with the gangues to escape by a trapped orifice, and recuperating the reacting metal contained in such residues and returning it to the superheater. 7 claims. Patented also in England, No. 16,834 of 1907.

1072 899,322. Process of treating complex ores containing zinc and other volatilizable metals for the production of oxides.—**George M. Rice**, Worcester, Mass. Filed July 25, 1907. Issued September 22, 1908.

The process of producing zinc oxide from sulphide ores, which consists in mixing with the crushed raw ore finely divided particles or chips of metallic iron in quantity sufficient to overbalance the sulphur requirements, and also sufficient to form a slag with the silica contained in the ore, charging such mixed ore and iron particles into a melting furnace and subjecting the same to heat, thereby vaporizing the volatile metals and melting the matte and slag residuals, oxidizing the metallic vapors as they pass off from the charge, and then condensing and collecting the oxidized product.

1073 900,845. Gas-furnace.—**Louis G. Fromont**, Liege, Belgium. Filed April 6, 1905. Issued Oct. 18, 1908.

"The claim is for special modes of arranging the burners and crucibles and directing the gas or flame currents, particularly in furnaces for the distillation of zinc, with a view to economize labor."
—J. S. C. I. Patented also in France, No. 353,462.

1074 901,405. Smelting-furnace.—**George A. Wettengel**, St. Louis, Mo. Filed Aug. 13, 1907. Issued Oct. 20, 1908. 9 claims. Patented also in Germany, no 224,457.

1075 902,534. Metallurgical condenser.—**Woolsey M. Johnson**, Hartford, Conn. Filed Jan. 8, 1908. Issued October 27, 1908. 17 claims.

1076 902,535. Method of condensing volatile metals.—**Woolsey M. Johnson**, Hartford, Conn. Filed Jan. 8, 1908. Issued October 27, 1908.

The method of condensing volatile metals which consists in bringing metallic vapors into contact with a body of molten metal and regulating the mass of the molten metal in contact with the vapors to secure substantially complete condensation of said vapors. 18 claims.

- 1077 905,280. Metallurgical process.—**Anson G. Betts**, Troy, N. Y. Filed Feb. 19, 1908. Issued Dec. 1, 1908.

The process of recovering a metal or metals including zinc, which consists in reacting on a material containing oxidized zinc with silicon. 11 claims.

- 1078 905,753. Process of extracting zinc.—**Edward H. Shortman**, Bloxwich, Eng., assignor of one-half to the New Delaville Spelter Co., Ltd., Spring Hill, Eng. Filed Dec. 13, 1907. Issued Dec. 1, 1908.

The improvement in the art of separating lead and zinc vapors in the extracting of zinc by distillation which consists in passing the metallic vapors prior to condensation through a lead-intercepting medium which separates the lead by a mechanical or physical action, the said medium being used until its lead-intercepting properties are impaired, and then displacing said intercepting medium into the retort and continuing the zinc-condensing process without interruption but without providing for the interception of the lead. Patented also in England, No. 7,223 of 1907 and No. 7,223a of 1907.

- 1079 906,191. Reduction of zinc oxides.—**Pierre-Armand Brangier**, Agnew, and **John J. Faulkner**, Berkeley, Cal. Filed May 29, 1907. Issued Dec. 8, 1908.

The process for producing metallic zinc said process consisting in heating the oxide of zinc to a volatilizing temperature then mixing therewith a body of hydrocarbon gas or vapor transferring the volatilized zinc to a chamber where the temperature is reduced to the point of fluidity of the zinc.

- 1080 907,416. Apparatus for extracting zinc.—**Edward H. Shortman**, Bloxwich, England, assignor of one-half to The New Delaville Spelter Company, Ltd., Spring Hill, Birmingham, England. Filed Sept. 17, 1908. Issued December 22, 1908.

Filter for lead fumes.

- 1081 914,339. Means for charging the retorts of zinc and other analogous furnaces.—**Emile DorDelattre**, Liege, Belgium. Filed July 1, 1908. March 2, 1909.

Patented also in England, No. 13,822 of 1908.

- 1082 914,839. Apparatus for use in smelting zinc ore, galvanizer's dross and the like.—**Evan H. Hopkins**, Addlestone, England. Filed Oct. 3, 1908. Issued March 9, 1909.

The combination with a zinc retort condenser, of a tube containing broken coke or charcoal, inserted at the mouth of the condenser. Patented in England, No. 25,099 of 1907.

- 1083 916,487. Ore reducing furnace.—**George F. Rendall**, New York, N. Y., assignor to American Reduction Company. Filed Nov. 20, 1906. Issued March 30, 1909.

A furnace for calcining ores having a chamber for heating the ore, a gas holder, and means connected therewith for admitting gas thereto without danger of combustion in said holder. 7 claims.

- 1084 919,375. Method of recovering zinc compounds and ammonia.—**Elias G. Pearlman** and **Martin M. Pearlman**, Philadelphia, Pa. Filed Oct. 3, 1908. Issued April 27, 1909.

The method of recovering zinc compounds and ammonia, which consists in roasting or smelting sal-ammoniac-fluxes or skimmings, by-products of the galvanizing process, acting on the gases and fumes given off first with steam then with an alkaline solution and finally treating the remaining gases with an acid solution.

- 1085 919,376. Apparatus for recovering zinc compounds and ammonia.—**Elias G. Pearlman** and **Martin M. Pearlman**, Philadelphia, Pa. Filed Oct. 6, 1908. Issued April 27, 1909.

A roasting or smelting furnace having a stack with a closed top and side conduit, a vessel for containing a solution, pipe connections from said conduit with said vessel, said pipe connections extending into and from said vessel to a tank having an escape pipe, and an injector device connected with the pipe connections from said conduit with said vessel.

- 1086 920,336. Method of manufacturing zinc oxide.—**Louis S. Hughes**, Joplin, Mo., assignor to Picher Lead Co. Filed Nov. 13, 1906. Issued May 4, 1909.

The method of manufacturing zinc oxide from zinc sulphide which consists in finely dividing the zinc sulphide ore or compound, heating a furnace by an internal gas flame to a temperature at which the zinc sulphide in admixture with air will be decomposed and zinc oxide formed, feeding the ore to the heated portion of the furnace by means of an air jet, separating the zinc oxide and furnace gases from impurities by subsidence and separating the zinc oxide from the gases by screening.

- 1087 920,337. Method of making zinc oxide.—**Louis S. Hughes**, Joplin, Missouri, assignor to Picher Lead Company. Filed Nov. 13, 1906. Issued May 4, 1909.

The method of manufacturing zinc oxide from zinc carbonate which consists in finely dividing the carbonate, maintaining a furnace at an internal temperature sufficient to decompose the carbonate by an internal gas flame, injecting the finely divided carbonate into the heated portions of the furnace to decompose it, separating the zinc oxide and furnace gases from impurities by subsidence and separating the zinc oxide from the gases by screening.

- 1088 921,375. Means for protecting operatives of zinc and analogous furnaces from heat, fumes, and dust.—**Emile Dor-Delattre**, Liege, Belgium. Filed Aug. 12, 1908. Issued May 11, 1909.

1089 922,906. Revolving furnace for volatilizing ores.—**Harry H. Hughes**, Springfield, Mo. Filed April 5, 1909. Issued May 25, 1909.

1090 927,857. Process of reducing zinc ores.—**Antoine H. Imbert**, Grand-Montrouge, France, assignor to Imbert Process Company, New York, N. Y. Filed Sept. 8, 1908. Issued July 13, 1909.

The process of reducing sulphide ores consisting in melting a mixture of the ore and peroxide of iron and treating the molten mixture with a reactive metal. 9 claims.

1091 932,279. Furnace for volatile metals.—**Woldemar Hommel**, London, England, assignor to Metals Extraction Corporation. Filed Nov. 30, 1908. Issued Aug. 24, 1909.

1092 936,245. Apparatus for filling zinc-retorts with granular material.—**John D. James**, Pulaski, Va. Filed Nov. 12, 1906. Issued Oct. 5, 1909. 6 claims.

1093 947,831. Manufacture of zinc.—**Oscar Loiseau**, Sclaig-neaux, Belgium. Filed June 17, 1908. Issued February 1, 1910.

A mixture of oxidized ore and carbon is subjected to the direct reducing action of carbon monoxide in a practically pure state, not mixed with nitrogen, at the temperature required for the reduction of the zinc.

1094 948,740. Process for obtaining zinc from zinciferous materials.—**Herman Pape**, Hamburg-Billwärder, Germany. Filed Sept. 30, 1909. Issued Feb. 8, 1910.

Consists in feeding into a smelting furnace a charge of small fuel, briquets composed of pulverized zinciferous materials and a reducing agent, and finally lumps of zinciferous material, followed at predetermined intervals by a series of such charges superposed one on top of another.

1095 953,405. Smelting furnace.—**Charles A. Wettengel**, Caney, Kans., assignor to American Zinc, Lead and Smelting Company, Boston, Mass. Filed July 22, 1909. Issued March 29, 1910. 7 claims.

1096 958,150. Regenerative furnace.—**Frank Meyer**, Englewood, N. J., assignor to Metallurgical Company of America, New York. Filed October 24, 1905. Issued May 17, 1910.

1097 959,924. Smelting process.—**Edward Dedolph**, Kaslo, British Columbia, Canada. Filed November 4, 1909. Issued May 31, 1910.

The continuous process of extracting lead or zinc or both from their ores or slag as oxide in the form of fume, which consists in continuously supplying the material mixed with fuel, to an inclosed

chamber, causing the material to travel slowly along the bottom of said chamber, admitting flame and air to the chamber, the flame being admitted at a region remote from the region where the material is admitted to the chamber, continuously liberating the metal as oxide in the form of fume and carrying off and collecting the fume thus formed, and continuously removing the residue from the chamber. Patented also in France, No. 421,910.

- 1098 963,416. Extraction of zinc.—**Charles Brand**, Troon, Scotland, assignor to Brand's Pure Spelter Company, Ltd., Glasgow, Scotland. Filed Feb. 16, 1910. Issued July 5, 1910.

A furnace heated retort furnished with a filter, comprising a container, a charge of refractory material within the container, the container approximately filling the bore of the retort and being situated entirely within the retort at a place to ward the front thereof, where the retort is directly heated by the furnace. Patented also in England, No. 9,955 of 1909; in France, No. 412,842.

- 1099 969,254. Apparatus for charging the retorts of zinc and other analogous furnaces.—**Emile DorDelattre**, Liege, Belgium. Filed May 6, 1910. Issued September 6, 1910.

- 1100 974,257. Metal-reducing process.—**Frederick W. Gordon**, Philadelphia. Filed Sept. 25, 1908. Issued November 1, 1910.

That improvement in the art of reducing the ores of volatile metals and recovering the metal therefrom which comprises the following steps, viz: establishing and maintaining a columnar furnace-charge comprising commingled ore and fuel; establishing and maintaining therethrough an upward current represented by air injected at the base of the column and by gases discharged at the top of the column; establishing and maintaining within the column two successive zones, a lower one of reduction and gasification and metal vaporization and an upper one of metal-vapor condensation; withdrawing from between said zones some of the furnace gases with their quota of metal vapor; condensing a portion of the metal vapor contained in said withdrawn gases; and recovering the metal resulting from said condensation. 8 claims. See also item 873.

- 1101 975,217. Treatment of zinc ores by the precipitation process.—**Adolphe Desgraz**, Hanover, Germany, assignor to Imbert Process Company, New York. Filed Dec. 6, 1909. Issued November 8, 1910.

A process for the extraction of zinc from zinc sulphide ores which consists in employing lead slag as a dissolvent for the ore and subsequently precipitating the zinc by a reacting metal (iron) having a greater affinity for sulphur than has zinc. Patented also in France, No. 407,305.

- 1102 976,557. Process of producing metallic zinc.—**Oliver B. Dawson**, El Paso, Tex. Filed March 16, 1909. Issued Nov. 22, 1910.

Consists in introducing into the zinc vapors at or above the zone of combustion carbon monoxide in sufficient quantity to combine with any unconsumed particles of oxygen.

- 1103 980,640. Furnace for volatilizing zinc from its ores.—**Harry H. Hughes**, Springfield, Mo., assignor of one-half to F. X. Heer and A. J. Eisenmayer, Springfield, Mo. Filed Feb. 11, 1910. Issued January 3, 1911. 12 claims. Patented also in England, no. 570 of 1911; in France, no. 425,341.

- 1104 980,641. Method of treating zinc ores for the recovery of metallic zinc therefrom.—**Harry H. Hughes**, Springfield, Mo. Filed April 6, 1910. Issued Jan. 3, 1911.

The continuous method of volatilizing metallic zinc from its ores, consisting in introducing the ores into a heated retort, agitating the ores while contained within the retort, passing the volatilized metal and residue from the retort into a condensing chamber, permitting the escape of the condensed metal from the condensing chamber, and removing the residue from the condensing chamber.

- 1105 993,019. Manufacture of zinc oxide.—**Abraham Blum**, Montreux, Mexico. Filed Oct. 17, 1910. Issued May 23, 1911.

The method of making zinc oxide from zinciferous materials, such as calcined zinc ore, crude ore, and the like, which consists in establishing a charge made up of a plurality of layers of zinciferous material mixed with crushed fuel for reduction, alternating with a plurality of layers of crushed fuel constituting auxiliary heating zones therefor, blasting the charge with air, and recovering the resultant zinc oxide fumes. 9 claims. Patented also in England, No. 29,485 of 1910; in France, No. 424,380. See also item 912.

- 1106 993,513. Means for withdrawing dust and fumes from zinc or similar furnaces.—**Emile Dor Delattre**, Liege. Filed June 19, 1908. Issued May 30, 1911.

The combination with a zinc or similar furnace having two vertically separated passages, the upper one arranged to receive fumes generated in the furnace and the other communicating with the chamber of the furnace wherein relatively heavy solid particles of dust from the retorts crucibles, etc., collect, of a stack or chimney communicating with both said passages, and a flue arranged within the stack and adapted to receive the highly heated gases escaping from the combustion chamber of the furnace, the heights and diameters of the stack and flue being so proportioned that a large volume of air is caused to move rapidly through the space separating them and effectually carry off both the fumes and the relatively heavy dust produced by operating the furnace. Patented also in France, No. 391,513.

- 1107 1,002,037. Metallurgy of Zinc.—**Frank L. Clerc**, Boulder, Colo. Filed Apr. 24, 1911. Issued Aug. 29, 1911.

The method of reducing zinc oxide by carbon and recovering the resulting zinc vapors, which consists in establishing a trapped body of molten metal in the bottom of a retort, said trapped body of metal terminating the outside of the retort in an outer well, supplying a charge of zinc oxide and carbon to the surface of the trapped portion within the retort, heating the metal in the outer well, and reducing the zinc oxide of the charge by the carbon, by means of heat conducted from the well through said molten metal to the surface of the portion trapped within the retort. See also 1,012,816.

—Described in Met. & Chem. Eng., vol. 9, p. 609. Nov., 1911.

- 1108 1,003,051. Process for the treatment of sulphureted copper-zinc ores in a converter.—**Desire Korda**, Paris, France, assignor to Société Commerciale des Mines, Minerais et Metaux, Paris. Filed August 16, 1910. Issued September 12, 1911.

The method of treating sulphureted copper and zinc ores, rich in zinc, which method consists in mixing said ore with coke in small pieces, melting said mixture in a converter formed with an interior lining containing a high proportion of coke, injecting compressed air into said molten metal, and prior to swinging the converter adding to the molten mass a small quantity of pyrites containing very little copper and zinc. Patented also in France, No. 430,159.

- 1109 1,007,124. Manufacture of oxide of zinc for smelting.—**Ralph MacIvor** and **Waldemar Hommel**, London, England, assignors to the Metals Extraction Company, Ltd., London. Filed Aug. 22, 1910. Issued Oct. 31, 1911.

Densifying light zinc oxide by converting it into oxychloride which sets, and expelling the zinc chloride therefrom by heat, thus leaving zinc oxide of increased specific gravity. Patented also in England, No. 19,386 of 1909.

—Described in Met. & Chem. Eng., vol. 10, p. 51. Jan., 1912.

- 1110 1,007,990. Method or process for the reduction and smelting of ore and arrangement therefor.—**Filip Tharaldsen**, Trondhjem, Norway. Filed May 31, 1911. Issued November 7, 1911.

Method of reducing and smelting ores, which consists in feeding a charge consisting principally of ore into the top of a suitable furnace, supplying charges of solid material comprising a reducing agent to said first named charge during the passage of the latter through the furnace at points near the melting zone, so as to control the proportions of ore and reducing agent required in the charge toward and within the melting zone, and at the same time feeding in said charge comprising the reducing agent so that it forms a layer on the interior side of the furnace which forms an envelope entirely surrounding or inclosing the central charge consisting principally of ore. 10 claims.

- 1111 1,009,863. Furnace for extracting zinc.—**Otto Schneemilch**, **Wilhelmshütte**, near Schoppinitz, Germany. Filed July 28, 1911. Issued Nov. 28, 1911.

A furnace for extracting zinc ores comprising a chamber to which hot gases are admitted, vertical retorts passing their whole length freely through said chamber so as to be uniformly surrounded by the hot gases over their whole length and means whereby said retorts may be removed from below said chamber. 6 claims. Patented also in England, No. 18,003 of 1911.

- 1112 1,012,816. Metallurgy of zinc.—**Frank Clerc**, Boulder, Colo. Filed November 4, 1911. Issued December 26, 1911.

Apparatus for reducing zinc oxide by carbon, comprising a plurality of retorts closed at bottom by a trapped body of substantially

quiescent molten metal terminating in a well exterior to the retorts, a continuous heating chamber inclosing the common well, and means for directing fuel in combustion across the upper surface of the metal in the well. See also 1,002,037.

—Described. *Met. & Chem. Eng.*, vol. 10, p. 556. Sept., 1912.

- 1113 1,014,062. Method of producing zinc oxide.—**Harry H. Hughes**, St. Louis, Mo. Filed May 27, 1911. Issued January 9, 1912.

The continuous process of producing zinc oxide from sulphide and other sulphur bearing ore consisting in roasting the ore to eliminate practically all of the sulphur in the form of fumes, delivering the roasted ore while still in a heated condition into a rotary reduction furnace, the interior of which is heated solely by the combustion of liquid or gaseous hydrocarbon within said furnace, causing the heated ore to pass through the furnace, and introducing air into said furnace to reduce the zinc vapor to an oxide.

—Described. *Met. & Chem. Eng.*, vol. 10, p. 179. Mar., 1912.

- 1114 1,014,333. Mechanical device for charging and cleaning zinc retorts.—**Otto Saeger**. Issued Jan. 9, 1912.

—Described in *Met. & Chem. Eng.*, vol. 10, p. 179. Mar., 1912.

- 1115 1,030,676. Zinc distillation.—**John Moulden and Harold Webster**, Seaton Carew, England, assignors to Central Zinc Company, Ltd. Seaton Carew, England. Filed Dec. 29, 1910. Issued June 25, 1912.

The step in the process of zinc distillation which consists in bringing into contact with retort vapors a haloid salt to prevent the formation of zinc oxide. 9 claims. Patented also in England, No. 5,196 of 1911; in France, No. 423,912.

- 1116 1,038,205. Preheater for zinc furnaces.—**Carl Roitzheim**, Germany. Issued Sept. 10, 1912.

—Described in *Met. & Chem. Eng.*, vol. 10, p. 697, Oct., 1912.

- 1117 1,041,977. Zinc-retort-furnace.—**Charles A. H. De Saulles**, Gas, Kansas, assignor to New Jersey Zinc Company, New York. Filed April 22, 1911. Issued October 22, 1912.

A zinc retort furnace provided with a combustion chamber having an exit flue for the products of combustion at one end thereof, zinc retorts located within the chamber, a series of air ports and a series of gas ports opening into the combustion chamber below the retorts, an air pressure main and a gas pressure main communicating with the said air and gas ports respectively, and valves for controlling independently the air supply and the gas supply from the mains to each of the air and gas ports.

—Described, with diag., in *Met. & Chem. Eng.*, vol. 10, p. 816. Dec., 1912.

- 1118 1,047,360. Process of separating zinc and lead from mixed sulphides.—**Carl L. W. Witter**, Hamburg, Germany. Filed Nov. 8, 1909. Issued Dec. 17, 1912.

Comprises comminuting the ores, subjecting them to oxidizing roasting to eliminate the greater part of their sulphur content, briquetting the ore with a reducing agent and a binder, charging the briquets so formed into a suitable furnace in the presence of a non-oxidizing atmosphere and substantially out of contact with the flame of the furnace and on a fluid slag under-layer sufficiently thick to maintain a substantially uniform temperature within the furnace, thereby reducing and evaporating the zinc, oxidizing and cooling the zinc vapors, and recovering the zinc as oxide of zinc. 7 claims. Patented also in France, No. 408,612. See also item 923.

- 1119 1,048,420. Zinc-furnace.—**George Londress and Webster Worley**, Grafton, W. Va. Filed June 25, 1912. Issued Dec. 24, 1912.

A furnace comprising front and rear buck-stays, interlocking connecting members between the front buck-stays to maintain the latter in spaced relation, each of the interlocking members having a recess therein, and fire brick material in the recesses of said members to protect the same from heat and flame and adapted to form retort supports. 15 claims. Patented also in England, No. 11,900 of 1913.

- 1120 1,048,603. Hydro-electric smelting-furnace.—**Antonio Tomasini**, New York, N. Y., assignor of one-half to **Marcellus E. Thornton**, Hickory, N. C. Filed Aug. 1, 1912. Issued Dec. 31, 1912.

In a smelting furnace, the combination of a reheater or crucible, and electrically heated hydrogen supplying furnace in communication therewith, a rotatably mounted tubular hearth in communication with the reheater, a charging means for supplying ore to the hearth, and a hydrogen retriever in communication with the charging end of the hearth.

- 1121 1,049,569. Gas-furnace.—**Alexander Folliet**, Brussels, Belgium. Filed July 20, 1911. Issued January 7, 1913. 10 claims.

- 1122 1,049,570. Zinc furnace.—**Alexandre Folliet**, Brussels, Belgium. Filed Sept. 21, 1911. Issued January 7, 1913. 12 claims. Patented also in England, no. 2,250 of 1911; in France, no. 430,942.

- 1123 1,049,746. Process of treating metal and mineral bearing materials.—**John L. Malm**, Denver. Filed August 9, 1909. Issued January 7, 1913.

The process of treating ore which consists in subjecting the same in a suitable receptacle to the action of a salts-forming gas for a sufficient length of time to form the salts of only part of the metal or metals, and introducing a cooling agent with the halogen gas in the receptacle. 21 claims.

- 1124 1,051,512. Ore-reducing furnace.—**Peter Evert Peterson**, Butte, Mont. Filed May 10, 1912. Issued January 28, 1913.

- 1125 1,059,307. Apparatus for the manufacture of metallic zinc. **Robert Denis Lance**, La Garenne-Colombes, France, assignor to **Pierre Ferrere**, Paris, France. Filed Feb. 26, 1913. Issued April 15, 1913.

In an apparatus for manufacturing zinc, a retort, a central heating chamber therefor, the ends of the retort being extended through the walls of said central heating chamber, an inverted bottle shaped member disposed outside of said central heating chamber, a conduit connecting said retort with said bottle shaped member, a collector arranged to receive the open end of said bottle-shaped member, and means for regulating the temperature of said conduit, said bottle-shaped member, and said collector.

- 1126 1,069,085. Process of recovering zinc and other volatile metals.—**Thomas Huntington**, London, England, and **Ferdinand Heberlein**, Frankfort-on-the-Main, Germany. Filed Oct. 25, 1910. Issued July 29, 1913.

Consists in charging a comparatively thick layer of the ore or other material mixed with reducing fuel in a suitable furnace, igniting the charge at the top, forcing an air current downward through the charge, thereby generating within the body of the charge the combustion gases relied upon for heating, decomposing and reducing, decomposing and reducing by said downward escaping combustion gases the compounds of the charge which may be injurious to the subsequent production of metallic vapors, reducing the oxidizing constituents of the gas current by the incandescent fuel, distilling the volatile metals out of the charge, condensing the metallic vapors, sintering substantially the entire residues and discharging the sintered mass for preparing the furnace to receive a fresh charge. 9 claims. Patented also in England, No. 20,896 of 1910, No. 8,035 of 1911; in France, No. 435,143.

- 1127 1,072,209. Process of extracting zinc from residues containing zinc, especially slags, in reverberatory furnaces.—**Adolphe Henri Desgraz**, Hanover, Germany. Filed July 31, 1911. Issued September 2, 1913.

The process of recovering easily reducible and volatile metal from substances containing the same, which consists in forming such substances to a molten liquid bath of slag, and reacting upon said molten bath with a suitable basic agent, (calcium oxide) thereby driving off said metal from the bath. 6 claims. Patented also in Germany, No. 248,179.

—Described in *Met. & Chem. Eng.*, vol. 11, p. 656. Nov., 1913.

- 1128 1,073,461. Process for the separation of lead and zinc.—**Jules Babe**, Honfleur, France. Filed April 4, 1911. Issued September 16, 1913.

A process for the separation of lead and zinc contained in mixtures or combinations of salts or oxides of these metals, which con-

sists in sulphureting the lead in the presence of a volatile reducing agent at a temperature below that at which the zinc is affected. Patented also in France, No. 428,707.

- 1129 1,080,102. Process of reducing zinc compounds.—**Elisha B. Cutten**, Erie, Pa. Filed Sept. 15, 1913. Issued Dec. 2, 1913.

The process of reducing zinc compounds free from slag forming materials which consists in subjecting them in the absence of fluxing material but in the presence of carbon to a temperature ordinarily sufficient to vaporize metallic zinc, and under a pressure sufficiently high to prevent such vaporization, the zinc being thereby precipitated as molten metallic zinc.

- 1130 1,082,765. Condensation of zinc.—**Augustin L. J. Queneau**, Philadelphia, Pa. Filed April 23, 1912. Issued Dec. 30, 1913.

A condenser for zinc vapors, provided with baffle plates of carbon projecting into its interior. 14 claims.

- 1130a 1,082,766. Collector.—**Morley Punshon Reynolds**, Cleveland, Ohio, assignor to the W. S. Tyler Co. Filed Sept. 16, 1912. Issued Dec. 30, 1913.

- 1131 1,086,939. Muffle for reduction-furnaces.—**Alexander Roitzheim**, Duisburg-Ruhrort. Filed April 22, 1913. Issued Feb. 10, 1914.

A muffle for reduction furnaces, comprising a vertical casing having a gas chamber therein formed of a plurality of horizontally disposed slats, the adjacent edges of which form apertures. Patented also in England, No. 9,314 of April 21, 1913; in France, No. 456,636.

- 1132 1,100,490. Process for the recovery of zinc from its ores.—**Alex Roitzheim**, Düren, Germany. Filed August 28, 1911. Issued June 16, 1914.

The step in the process of zinc distillation in retorts, which comprises preheating the charge of ore and reducing material to a temperature above the condensation temperature of zinc and below the reducing temperature of the charge, (about 600° C.) thereby preventing zinc dust formation. Patented also in England. No. 19,587 of 1911.

- 1133 1,112,010. Treatment of zinc residues.—**Archibald Jones**, Bartlesville, Oklahoma, assignor to Bartlesville Zinc Co. Filed July 5, 1911. Issued September 29, 1914.

The method of treating zinc retort residues which consists in concentrating them by combustion of their carbon content and simultaneously volatilizing the contained zinc and catching the products of volatilization of the zinc in the outer layers of the pile. See also item 851.

- 1134 1,114,036. Metallurgy of zinc.—**Augustin L. J. Queneau**, Torresdale, Pa., assignor to Queneau Electric Zinc Furnace Company, Philadelphia, Pa. Filed Dec. 7, 1908. Issued October 20, 1914.

The method of extracting and recovering zinc from zinc ore, which consists in preheating said zinc ore, separately charging into a reducing furnace the ore in the preheated state and a reducing agent, intimately mixing them within the furnace, subjecting the mixture to a reducing atmosphere and a reducing temperature with exclusion of air, thereby releasing the zinc in the form of zinc vapor, and condensing said vapor to the metallic state. Patented also in France, No. 403,048.

- 1135 1,118,012. Process of smelting zinc ores.—**James M. Hyde**, Berkely, Cal. Filed Feb. 13, 1914. Issued Nov. 24, 1914.

The process of smelting zinciferous ores, which consists in heating the ore mixed with flux and reducing-agent in an externally heated retort to a temperature sufficient to reduce the metallic constituents, collecting the molten material in a bath beneath the charge, removing the zinc vapors from the retort above the molten bath, and keeping the bath molten by heat directly applied to the surface thereof outside said retort. 8 claims. Patented also in England, No. 2,221 of 1915; in France, No. 477,646.

- 1136 1,127,264 Smelting furnace.—**Edwin Vincent Lanyon** and **Frances Albert Curnow**, Pittsburg, Kansas. Filed April 11, 1914. Issued February 2, 1915. 15 claims.

- 1137 1,133,637. Process of preventing escape of noxious gases in smelting.—**William A. Hall**, New York. Filed June 25, 1913. Issued March 30, 1915.

In a process of smelting sulphides, the step of preventing the discharge of sulphurous gases into the atmosphere, which comprises maintaining a layer of said sulphides at the top of the charge, at a temperature below that at which sulphur will ignite, by spraying the top of the ore charge with a liquid containing water.

- 1138 1,136,304. Zinc-producing furnace.—**Albert Zavelberg**, Hohenlehenhütte, Germany. Filed August 25, 1914. Issued April 20, 1915.

In a zinc producing furnace the combination of a plurality of vertical, superposed rows of shafts, preheating chambers above the upper row of said shafts, a plurality of juxtaposed chambers within said shafts, walls separating said chambers, means within said walls for producing gas tight partitions between each two of said chambers, condensers in front of, and connected to the chambers of the various rows of shafts, and means for connecting the preheaters with the upper row and this upper row with the lower row of said shafts.

- 1139 1,137,835. Briquet for use in zinc furnaces.—**George S. Brooks**, Depue, Ill., assignor to the New Jersey Zinc Company, New York. Filed Nov. 28, 1913. Issued May 4, 1915.

A briquet for zinc furnaces, composed of zinc ore and coal surrounded by and inclosed within a protecting shell or coating containing a large percentage of common salt

- 1140 1,144,036. Zinc-smelting furnace.—**James M. Hyde, Berkeley, Cal.** Filed Mar. 10, 1915. Issued June 22, 1915. 11 claims.

- 1141 1,144,037. Method of smelting zinc and other ores.—**James M. Hyde, Berkeley, Cal.** Filed Mar. 10, 1915. Issued June 22, 1915.

The process of smelting zinciferous materials which consists in mixing with the zinciferous material a proper amount of reducing agent, charging the same into a retort while preventing the passage of vaporized zinc, through the charging device, vaporizing by external heat the zinc in the retort and separately removing the vaporized zinc and the solid residues from the retort while continuing the smelting operation, and preventing the passage of gas out of or into the retort through the opening through which the residues are withdrawn.

- 1142 1,144,066. Process and apparatus for removing drossy residues from vertical muffles in the extraction of zinc.—**Alexander Roitzheim, Duisburg, Germany.** Filed Sept. 22, 1913. Issued June 22, 1915.

- 1143 1,144,065. Mechanism for removing residues from vertical retorts.—**Alexander Roitzheim and Wilhelm Remy, Duisburg, Germany.** Filed Dec. 20, 1912. Issued June 22, 1915.

- 1144 1,145,685. Condenser for zinc and lead vapors.—**Edwin Andreas Johansson, Trollhättan, Sweden.** Filed April 21, 1915. Issued July 6, 1915.

A condenser having a loose bottom and means for rotating said bottom.

- 1145 1,152,050. Arrangement for preventing the formation of smoke in the production of zinc.—**Alexander Roitzheim, Duisburg-Ruhrort, Germany.** Filed April 1, 1913. Issued Aug. 31, 1915.

Patented also in England, No. 6,771 of 1913; in France, No. 455,726.

- 1146 1,153,203. Method of treating ores.—**Louis C. Drefahl, Cleveland, Ohio,** assignor to The Grasselli Chemical Company, Cleveland. Filed April 15, 1914. Issued September 14, 1915.

The method of conditioning fine or dusty ore material for further treatment, which consists in forming such material into a plastic mass; dividing up such mass into relatively small nodules; and then



ZINC RETORTS, HILLSBORO SMELTER,
American Zinc, Lead & Smelting Co.



REFRATORIES PLANT
Evans & Howard Fire Brick Co., St. Louis Co.

maintaining such nodules relatively stationary and simultaneously subjecting the same to heat sufficient to dry and harden but not otherwise affect the same.

- 1147 1,155,628. Method for the treatment of zinc or zinc-bearing material.—**Sewall Truax**, Canon City, Colo., assignor to Granadena Mining Company. Filed Dec. 16, 1910. Issued Oct. 5, 1915.

The method of treating slag containing zinc comprising maintaining the slag in a fluid condition in contact with a body of finely divided reducing material, the particles of which are prevented from passing into the fluid.

—Described in Eng. & Min. Jour., vol. 100, p. 803. Nov. 13, 1915.

- 1148 1,157,375. Process for the manufacture of spelter from ferruginous and admixed blende ores.—**John James Fingland**, Kaslo, British Columbia, Canada. Filed Sept. 10, 1915. Issued Oct. 19, 1915.

The steps in the process of manufacturing spelter from ferruginous and admixed lead and zinc blende ores, which consists in heating a mixture of crude ore, roasted ore and lime, thereby forming litharge, maintaining the heat treatment until the litharge has been driven off by volatilization, and subsequently continuing the heat treatment at a temperature of substantially 1500° C. until a liquid zinc calcic oxide sulphide matte is produced. 6 claims.

—Described, with flow sheet, in Min. & Sci. Press, vol. 112, p. 61. Jan. 8, 1916.

- 1149 1,161,885. Removing cadmium from zinc ores.—**Gilbert Rigg**, Palmerton, Pa., assignor to The New Jersey Zinc Company, New York. Filed Sept. 4, 1913. Issued Nov. 30, 1915.

See also 1,246,576, Nov. 13, 1917.

—Described in Jour. Soc. Chem. Ind. vol. 35, p. 124. Jan. 31, 1916.

- 1150 1,161,886. Removing cadmium from zinc ore.—**Gilbert Rigg**, Palmerton, Pa., assignor to The New Jersey Zinc Company, New York. Filed July 27, 1915. Issued Nov. 30, 1915.

—Described. Min. & Sci. Pres, vol. 112, p. 245. Feb. 12, 1916.

—Described. Met. & Chem. Eng. vol. 14, p. 220-21. Feb. 15, 1916.

- 1151 1,166,170. Process for the production of zinc.—**Otto Balt'n**, Lipine, Germany. Filed Jan. 3, 1914. Issued Dec. 28, 1915.

A method of extracting zinc from ores consisting in enclosing in a space rounded briquets formed of ore and a reducing agent, having

adjacent briquets touching each other only at a single part, the combined exposed area of the briquets being a large multiple of the limited area of said space; and exposing said briquets to direct action of heat.

- 1152 1,166,171. Process for smelting metallic ores.—**Otto Balt'n**, Lipine, Germany. Filed May 28, 1914. Issued Dec. 28, 1915.

A briquet comprising a compressed mixture of ore, gypsum and pitch.

- 1153 1,166,447. Zinc ore charges for retorts and method of treating the same.—**C. A. H. De Saulles**, New York. Issued Jan. 4, 1916.

The front part of a retort or muffle is fitted with a briquet of reducing agent and ore low in iron and lead, which retains these metals.

—Described in Jour. Soc. Chem. Ind., vol. 35, p. 259. Feb. 29, 1916.

—Described in Met. & Chem. Eng., vol. 14, p. 666, June 1, 1916.

- 1154 1,167,925. Apparatus for the extraction of zinc.—**Martin M. Pearlman**, Clarksburg, W. Va. Issued Jan. 11, 1916.

Combined filter and condenser.

—Described in Min. & Sci. Press, vol. 112, p. 484. April 1, 1916.

- 1155 1,168,401. Process of making briquets from zinc ores and material containing zinc.—**Otto Kippe**, Osnabrück, Germany, assignor to General Briquetting Company, New York. Filed Nov. 19, 1914. Issued January 18, 1916.

—Described in Jour. Soc. Chem. Ind. vol. 35, p. 475. Apr. 29, 1916.

—Described in Min. Wld. vol. 45, p. 246. Aug. 5, 1916.

- 1156 1,169,069. Desulphurizing and smelting ores.—**Arthur S. Dwight**, New York N. Y. Filed June 25 1908. Issued January 18, 1916.

The process of sintering and smelting ore initially in a fine condition, which consists in continually forming a relatively thin stream or layer of the ore, sintering said stream into a relatively strong and rigid sinter cake, at a point relatively remote from the region of smelting, continually moving the cake horizontally away from the region of the forming and sintering, projecting the forward part of the cake into the region of smelting and subjecting it to smelting action.

—Described in Jour. Soc. Chem. Ind. vol. 35, p. 314-15. Mar. 15, 1916.

1157 1,178,518. Clean-out apparatus for zinc furnaces.—**F. A. Hinkey**, Springfield, Ill. Issued Apr. 11, 1916.

1158 1,193,680. Recovery of zinc.—**Charles H. Fulton**, Cleveland, Ohio, assignor to **David B. Jones**, Chicago, Ill. Filed Dec. 24, 1914. Issued August 8, 1916.

The process of recovering zinc from zinc bearing ore, consisting in grinding and calcining the ore, mixing it with pulverized coke and a carbonaceous binder such as pitch or tar, the quantity of coke being such as to furnish the necessary carbon for reduction of all the metallic oxides in the ore, plus such an additional amount of coke that the weight of the briquet, after distillation, will not be less than forty to fifty per cent of the weight of the briquet before distillation and the quantity of binder being from twelve to fifteen per cent of the combined weight of the ore and the coke, briquetting the mixture under pressure in molds, heating the briquets to a temperature high enough to destructively distil and coke the carbonaceous binder without volatilizing the zinc-content of the ore, supporting the briquets against collapse or breaking down during such heating operation, and subsequently subjecting said briquets to the usual zinc distillation to recover the zinc. Patented also in England, No. 104,564 of 1916.

—Described. Jour. Soc. Chem. Ind. vol. 35, p. 969. Sept. 30, 1916.

1159 1,213,346. Retort apparatus.—**Edward Fink**, Milwaukee, Wis. Filed May 9, 1914. Issued January 23, 1917.

1160 1,213,347. Retort apparatus.—**Edward Fink**, Milwaukee, Wis. Filed May 9, 1914. Issued January 23, 1917.

1161 1,215,006. Method of treating zinc-bearing materials.—**Charles A. H. De Saulles**, New York, N. Y. Filed June 19, 1915. Issued Feb. 6, 1917.

The method consisting in charging a retort with molten zinc bearing material, heating the charge to approximately 1350 degrees centigrade; and then permitting the zinc vapor to rapidly expand at a relatively low temperature to form blue powder.

1162 1,215,007. Apparatus for treating zinc-bearing material.—**Charles A. H. De Saulles**, New York, N. Y. Filed June 28, 1915. Issued Feb. 6, 1917.

A retort having a vapor discharge opening and provided at one end with a closure having a feed opening, the closure below said feed opening being provided with an opening for the discharge of molten material and means for feeding molten material into the retort through said feed opening.

1163 1,221,045. Condenser for redistilling spelter.—**John G. Granberg**, Beckemeyer, Ills. Filed Dec. 8, 1916. Issued April 3, 1917.

1164 1,222,636. Smelting furnace.—**John Kirby**, Leechburg, Pa. Filed Dec. 13, 1916. Issued April 17, 1917.

1165 1,223,738. Smelting furnace.—**Edwin Ruck**, Swansea, Wales. Filed May 6, 1916. Issued April 24, 1917.

1166 1,224,057. Method of recovering zinc and iron from solutions thereof.—**Charles E. Baker**, Chicago Ills. Filed Jan. 26, 1917. Issued April 24, 1917.

A method of recovering zinc and iron from solutions containing the same, consisting in simultaneously precipitating the said metals in the form of a non-compact deposit, then effecting a separation of the metals by vaporizing the zinc, and recovering the zinc.

1167 1,227,050. Zinc smelting furnace.—**Julius W. Hegeler**, Danville, and **Herman Hegeler**, deceased, Danville, Ills., by **Louise Hegeler**, executrix, assignors to the Hegeler Zinc Company, Danville, Ills. Filed Nov. 17, 1913. Issued May 22, 1917.

1168 1,231,083. Process of producing pure zinc.—**Heinrich Specketer**, Griesheim-on-the-Main, Germany. Filed Sept. 2, 1913. Issued June 26, 1917.

The method of producing zinc from zinciferous materials which consists in mixing the zinciferous materials with carbonaceous material, then heating the mixture in the form of separate charges by direct heat and with agitation to such a degree as to cause the reduction of the impurities (such as, for instance, cadmium oxide and the like), together with volatilization of the reduction products thus freed, and then proceeding to the reduction of the zinc compounds. Patented also in England, No. 20,039 of 1913; in France, No. 461,905.

1169 1,233,652. Production of metallic zinc.—**August Joseph Francois De Bavay**, Kew, Victoria, Australia. Filed Feb. 23, 1916. Issued July 17, 1917.

A method of fractionally distilling zinc comprising passing the zinc fumes through a series of liquid zinc bubbling chambers heated respectively at substantially 900° C., 650° C., and 450° C. 9 claims. Patented also in England, No. 102,142 of 1916.

1170 1,237,141. Furnace.—**Richard Ziesing**, Cleveland, Ohio, assignor to The Grasselli Chemical Company. Filed May 4, 1916. Issued Aug. 14, 1917.

In a two-stage method of purifying zinc of heavier metals associated therewith, the steps which consist in melting the impure zinc in a chamber to allow the heavier metals to settle, drawing off the relatively pure zinc above the level of the heavier metal, distilling such drawn off metal and allowing the heavier part to drain back into such melting chamber.

1171 1,246,576. Apparatus for removing cadmium from zinc ores.—**Charles Pomeroy Fiske**, Palmerton, Pa., assignor to the New Jersey Zinc Company, New York, N. Y. Filed August 24, 1917. Issued Nov. 13, 1917.

- 1172 1,249,061. Process for producing spelter.—**Charles H. Fulton**, St. Louis, Mo., assignor to Metallurgical Laboratories, Chicago, Ill. Filed Jan. 22, 1917. Issued Dec. 4, 1917.

A process for manufacturing spelter which consists in forming zinc in the metallic form into objects that will retain substantially their original form and volume when subjected to zinc distillation temperatures, heating said objects to convert the metallic zinc in the same into vapor, and thereafter condensing said zinc vapor into spelter.

—Described in Met. & Chem. Eng., vol. 18, p. 539-40. May 15, 1918.

- 1173 1,249,960. Plastic composition and process of producing the same.—**Jefferson D. Hollingsworth** and **John Mitchem**, Kusa, Okla. Filed Jan. 4, 1917. Issued Dec. 11, 1917.

A plastic composition for use in manufacturing retorts, comprising substantially 36 pounds of fire clay, substantially 59 pounds of fire clay cement, substantially 14 pounds of graphite and substantially one pound of common salt.

—Described in Met. & Chem. Eng., vol. 18, p. 551. May 15, 1918.

- 1174 1,250,071. Zinc extracting furnace with vertical retorts.—**Roman Von Zelewski**, Engis, Belgium. Filed Feb. 24, 1917. Issued Dec. 11, 1917.

In a furnace of the character described the combination of a casing formed with a vertical passage, gas and air ducts formed in the casing and communicating with the vertical passage, a platform located under the vertical passage to support the vertical retort and close the bottom of the same, counter weights, guides in the casing, and cables attached to the platform and counter weights to hold the retort in the passage.

- 1175 1,250,261. Method of and apparatus for recovering volatile metallic values in the form of metallic oxides from molten slag.—**Herman Witteborg**, Caldwell, Idaho. Filed Mar. 6, 1917. Issued Dec. 18, 1917.

The method of recovering volatile metallic values from molten slag, which includes the steps of causing the molten slag, containing suitable reducing agent, to flow in a comparatively shallow layer, through an inclosed super-heating zone; directing a sufficiently intense naked flame and its hot gases, into positive intimate contact with the shallow layer of flowing slag, to cause the vaporization of the metallic values to be recovered; oxidizing the metallic vapors arising therefrom and finally collecting the oxidized vapors in the form of metallic oxides.

—Described in Met. & Chem. Eng., vol. 18, p. 551. May 15, 1918.

- 1176 1,261,342. Process for the production of zinc.—**Otto Baltin**, Lipine, Germany. Filed Feb. 25, 1914. Issued April 2, 1918.

A process for the treatment of zinc ores which consists in adding naphthalene to a mixture of the zinc ore and reducing agents; and briquetting the material.

- 1176a 1,269,110. Continuous process for recovering lead or zinc or both metals from their ores or from slag in the form of metal fumes whereby the charge is mixed with fuel.—**Friedrich Ohlmer**, Griesheim, near Frankfort-on-the-Main, Germany. Filed September 26, 1914. Issued June 11, 1918.

The continuous process of recovering lead or zinc or both metals in the form of oxides from their ores and slags, which comprises feeding a mixture of the metalliferous material with carbonaceous fuel into a revolving furnace, heating the mixture therein in immediate contact with a heating flame to a temperature sufficient to effect the desired reduction without smelting the charge, maintaining a reducing atmosphere in the reduction zone of the furnace so as to avoid immediate reoxidation of the disengaged metal fumes in said zone, and oxidizing said fumes thereafter in an oxidizing zone.

- 1177 1,271,172. Cadmium-evolving process.—**Woolsey McA. Johnson**, Hartford, Conn. Filed July 30, 1914. Issued July 2, 1918.

A process for differentially reducing a cadmium-zinc bearing material; comprising obtaining the material with a considerable sulphur-content and then subjecting the said sulphur-bearing material under reducing conditions to a temperature sufficiently high to evolve cadmium vapors but too low to evolve zinc vapors.

- 1178 1,271,560. Apparatus and method for condensing zinc vapor.—**Charles H. Fulton**, St. Louis, Mo., assignor to Metallurgical laboratories, Inc., Chicago, Ill. Filed Jan. 8, 1917. Issued July 9, 1918.

A zinc condenser provided with tubular shaped members arranged one within the other and spaced apart so as to form a passageway through which a gas stream from a zinc distilling apparatus travels. 22 claims.

- 1179 1,274,249. Process of treating zinc.—**Charles A. H. De Saules**, New York, N. Y. Filed November 3, 1915. Issued July 30, 1918.

The process of treating metallic zinc consisting in first melting zinc containing lead, and eliminating by gravity therefrom a large amount of the lead; then heating to volatilization the zinc thus treated, and thereby eliminating therefrom most of the lead which remains; then condensing to a molten condition the zinc thus volatilized; and then collecting the zinc thus condensed and retaining it in a molten condition until a relatively large body thereof has been amassed. 9 claims.

- 1180 1,274,120. Retort-charging machine.—**George W. Whipple** and **Cloise H. Baldwin**, Cherryvale, Kans., assignors to Edgar Zinc Company. Filed June 7, 1917. Issued July 30, 1918. 11 claims.

- 1180a** 1,275,045. Process for utilizing the residues obtained in the distillation of zinc.—**Rudolf Koehler** and **Otto Balthin**, Lipine, Germany. Filed Jan. 3, 1914. Issued August 6, 1918.

A process for utilizing the residue of zinc distillation, said process comprising placing a new charge of zinc ore above a glowing residue of a previous charge in which residue some of the flux remains; heating and reducing the new charge from the residue by passing a strong blast through the residue and thence through the new charge; and heating and distilling the new charge, and condensing the vapors thereof, while shut off from the drafts of gas.

- 1180b** 1,279,292. Apparatus for treating zinc.—**Charles A. H. De Saulles**, New York. Filed July 10, 1917. Issued September 17, 1918.

In an apparatus for treating zinc, a melting furnace provided with means which permit separation of lead from zinc by gravitation, a distilling furnace provided with means by which molten zinc from the melting furnace may be fed therein and provided with a plurality of condensers into which the distilled zinc is discharged and condensed to liquid, and a mixing furnace provided with means for receiving molten zinc from the condensers.

- 1180c** 1,280,593. Furnace for treating zinc.—**Leopold Van Gulck**, Uplands, Swansea, Wales. Filed July 21, 1917. Issued October 1, 1918. Patented also in England, No. 113,393 of 1917.

- 1180d** 1,282,847. Zinc retort furnace.—**Archibald Jones**, Langeloth, Pa., assignor to Metallurgical Company of America, New York, a corporation of New Jersey. Filed Jan. 4, 1916. Issued October 29, 1918. 7 claims.

- 1180c** 1,287,949. Refining of zinc.—**Guy Carey Fricker**, Luton, Eng. Filed Jan. 27, 1917. Issued Dec. 17, 1918.

The method of obtaining high grade zinc from an impure grade of zinc which consists in causing the zinc produced by heating a charge of impure zinc to pass through a filter of inert material, arranged above, floating upon and completely covering the molten charge of impure zinc so that the zinc vapor is constrained to pass upward wholly through said filter and condensing the resulting purified zinc vapor. Patented also in England, No. 110,970 of 1916.

- 1180f** 1,291,654. Vertical zinc furnace.—**Ferdinand Fiechtl**, Chervyvale, Kans. Filed Nov. 2, 1917. Issued Jan. 14, 1919.

- 1180g** 1,292,330. Method of treating zinc ore.—**David B. Jones**, Chicago, Illinois. Filed June 22, 1914. Issued Jan. 21, 1919.

The method of recovering zinc oxide from zinc ore, consisting in forming the zinc ore into briquets with suitable reducing material, passing said briquets through the heating chamber of a suit-

able furnace in which the briquets are subjected to a sufficient degree of heat to expel their zinc content substantially in the form of metallic vapor, and supplying air to the space or chamber containing such vapor for the purpose of converting it into zinc oxide.
4 claims.

Great Britain

- 1181 22,694 of 1891. A novel system of regenerative gas furnace for the reduction of zinc ores.—**E. Dor.** Ampsin, Belgium.

"Duplicate kilns, built back to back and communicating with each other by passage below the retorts, are arranged with four regenerative chambers at each end at the ground level."

- 1181a 15,761 of 1894. Treating zinc sulphides in a blast furnace with ferric oxide, and thus producing metallic zinc direct.—**R. Biewend,** Clausthal, Germany.

—Described in Jour. Soc. Chem. Ind., vol. 14, p. 663. July 31, 1895.

- 1182 22,361 of 1896. Improvements in the extraction of lead, zinc, gold, silver and other metals from sulphides, refractory or other ores or mattes.—**J. Armstrong,** London.

The zinciferous material is heated with carbonate or nitrate of soda or potash, lime and carbon in a reducing atmosphere. The charge melts and separates into three layers, of which the top layer is a mixture of zinc, zinc salts and soda salts. This is further distilled. See also 16,312 of 1898.

- 1183 30,152 of 1896. Process of recovering zinc from zinciferous gases in the distillation and smelting of zinc.—**R. H. T. Biewend,** Clausthal, Germany.

"The zinc bearing gases are dry-filtered through condensers filled with fragments of charcoal or other porous or rough substance."

—Described in Jour. Soc. Chem. Ind., vol. 17, p. 159. Feb. 28, 1898.

- 1184 1,034 of 1897. Reduction of zinc blende and other ores, and recovery of lead with other metals therefrom.—**H. R. Angel,** London.

Treating zinc-lead sulphide ores in a reverberatory furnace with sulphate of soda and coal. The lead, containing most of the silver and gold is tapped out, whilst the volatile metals (zinc, etc.) are to be collected in chambers.

- 1185 8,990 of 1897. Improvements in or relating to the smelting of mixed minerals, ores, and the like containing lead and zinc.—**G. H. Blenkinsop,** Swansea.

Smelting zinc-lead sulphides in a blast furnace and maintaining the exit at a higher temperature than the volatilization of zinc.

- 1186 4,911 of 1898. Recovery of zinc from zinciferous slags or residues.—**H. E. Fry**, London, and **R. Addie**, Llansamlet.

"Zinc slags, etc., are mixed with carbonaceous matter and heated to a high temperature in a regenerative gas furnace, lined with dolomite or other basic material, and stirred with a green wood pole. The zinc is reduced, the fumes condensed, and the oxide collected."
—J. S. C. I.

- 1187 7,904 of 1898. Method and apparatus for reducing zinc ores and other volatile metals in blast furnaces.—**A. M. G. Sebillot**, Paris.

Improvements in ordinary zinc smelting from oxide and carbonate, chiefly for the prevention of volatilization.

- 1188 14,523 of 1898. Improved furnace for treating sulphides containing zinc and other ores.—**H. R. Angel**, London.

"Furnace for the inventor's process of treating zinc-lead sulphides and recovering caustic soda."—E. & M. J.

- 1189 15,645 of 1898. Treatment of refractory sulphide ores.—**F. Ellershausen**, London.

"In smelting zinc-lead ores in a cupola or blast furnace, uses an additional exhaust sufficiently powerful to prevent any zinc accretions forming in the furnace."—J. S. C. I.

- 1190 16,312 of 1898. Improvements in the smelting of complex sulphide ores containing zinc and lead.—**J. Armstrong**, London. Addition to 22,361 of 1896.

- 1191 16,388 of 1898. Improvements in the extraction of zinc from its ores.—**J. Armstrong**, London.

Roasting, mixing with an alkali salt, with or without fluxing material, lixiviating the soluble matter, and distilling with carbon.

- 1192 3,475 of 1899. Production of zinc oxide.—**Guy de Bechi**, Paris.

"Precipitated hydrated oxide of zinc is heated to a bright red heat, and the calcined residue compressed, with or without the addition to it of carbon and a binding agent. The treatment is applied to the wet zinc process for the purpose of decomposing the oxychloride of zinc which remains with the precipitated hydrate, and so obtaining a purer oxide for reduction to metal."—J. S. C. I.

- 1193 17,057 of 1899. Zinc-lead ore treatment.—**Guy de Bechi**, Paris, France.

Process for smelting zinc-lead ores in a cupola furnace with common salt, whereby the zinc is driven off and the lead reduced.

- 1194 3,462 of 1900. Treating zinc ores and apparatus therefor.—**J. Armstrong**, London.

Blast furnace for reducing, volatilizing and condensing zinc out of contact with air. The method of condensing is especially claimed and can be adapted to any kind of furnace. Same as German Patent 132,139, Sept. 14, 1900.

- Described in Jour. Soc. Chem. Ind., vol. 20, p. 367. Apr. 30, 1901.
- Described also in Zeits. f. angewandte Chem., vol. 15, p. 766. July 29, 1902.
- 1195 3,668 of 1900. Treating complex ores (lead, zinc, sulphur, etc.), and apparatus therefor.—**J. W. Worsey**, St. Helens, and **J. H. Lancashire**, London. Patented also in Germany, no. 135,056.
- Described in Jour. Soc., Chem. Ind., vol. 20, p. 367. Apr. 30, 1901.
- 1196 10,915 of 1900. Process for extracting zinc, and apparatus therefor.—**Jules L. Babe** and **Alexis Tricart**, Paris.
- “The zinc ore, mixed with coal and carbonate of soda, is heated in a special retort, whereby the zinc is extracted in one-third the time previously required.”—J. S. C. I.
- 1197 15,166 of 1900. Treatment of slags and by-products containing zinc.—**H. F. Kirkpatrick-Pickard**, London.
- Process of finely grinding, roasting, briquetting with carbonaceous material, and distilling.
- 1198 22,570 of 1900. Recovery of zinc from sulphide ores.—**H. F. Kirkpatrick-Pickard**, London.
- “The process is for the treatment of unroasted sulphide ores by mixing them with a reducing agent, such as lime, iron or iron oxide, and a carbonaceous material suitable for coking, forming briquettes, and distilling the same in such a manner as to first form a coke and then reduce and volatilize the zinc, the resulting sulphide of calcium or iron and any non-volatile metals remaining in minute particles in the coke.”—J. S. C. I.
- 1199 493 of 1901. Treatment of zinc ores.—**H. M. Taquet**, Argenteuil, France.
- “The process consists of the production, in one operation, of metallic zinc and alkaline earth sulphides by distilling, in zinc furnaces and in the presence of carbon, the compounds of zinc composed of oxide of zinc and the sulphate of an alkaline earth. The latter are produced by precipitating the mixed solution of chloride and sulphate of zinc with lime, baryta or strontia.”—J. S. C. I.
- 1200 2,782 of 1901. Treatment of ores containing zinc.—**J. G. Butterfield**, Balham, Surrey. Feb. 8, 1901.
- “The ores are roasted without fritting, and the product ground with caking coal to which limestone is added as a flux. The ore mixture is placed on a tray within a horizontal cylindrical iron retort, projecting beyond the furnace. An air-pump is provided for obtaining a vacuum within the retort to assist the distillation of the zinc.”—J. S. C. I.
- 1201 8,175 of 1901. Method of and means for casting and simultaneously refining raw zinc and other metals excepting

- iron.—**E. Herter**, Beuthen, Silesia. Patented also in Germany, no. 132,141.
- Described in Jour. Soc. Chem. Ind., vol. 20, p. 724. July, 1901.
- German patent described in Zeits. f. angewandte Chem., vol. 15, p. 687. July 8, 1902.
- 1202 15,831 of 1901. Zinc or other distillation furnaces.—**Erminio Ferraris**, Monteponi, Sardinia, Italy.
- Arranges the retorts so as to economize fuel and facilitate equalization of heating.
- Described in Jour. Soc. Chem. Ind., vol. 20, pp. 997-998. Oct. 31, 1901.
- 1203 17,415 of 1901. Reduction of zinc ores.—**L. Braunfels**, Frankfort-am-Main.
- The ores are briquetted and "heated in an iron reduction vessel having a condenser and suitable connections, to a sufficiently high temperature to distil the zinc, a vacuum being induced; and finally a current of carbon monoxide or other inert gas is passed through to lead the zinc vapors to the condenser."—J. S. C. I.
- 1204 14,982 of 1902. Treatment of zinc ores and other zinc material.—**J. R. Down**, Swansea, England.
- The ores are briquetted with coal by the use of from $\frac{1}{2}$ to 2 per cent by weight of sago flour, the proportion of coal being about 30 per cent.
- 1205 16,723 of 1902. Saving zinc fumes.—**R. W. Western**, London.
- Catching zinc fumes by agitation in a solution of sulphate of ammonia and precipitating as zinc hydroxide by addition of aqueous ammonia.
- 1206 6,185 of 1905. Fume recovery.—**G. A. Mower**, London.
- "Fixing a hood around furnaces, such as zinc distilling furnaces, and drawing such fumes away by a fan to a settling chamber."—E. & M. J.
- 1207 14,573 of 1905. Reduction of zinc sulphides.—**Soc. Anon. Metallurgique Procèdes de Laval**, Frankfort.
- Reducing zinc from roasted sulphides by injecting the latter, together with carbon finely pulverized, into a whirling atmosphere of carbonic oxide gas.
- 1208 20,380 of 1905. Smelting zinc-lead sulphides.—**F. Mackay & A. J. Beckwith**, Melbourne, Australia.
- "A process for smelting zinc-lead and other sulphides by injecting the ore in a state of very fine powder, together with a current of air, into a hot chamber; and methods of treating the oxides and sulphates so formed."—E. & M. J.
- 1209 98 of 1906. Retort discharging apparatus.—**An. de Biache St. Vaaste**, Paris, France.

- "Apparatus for discharging zinc retorts by means of a blast of compressed air or steam."—E. & M. J.
—Described in *Eng. & Min. Jour.*, vol. 82, p. 636. Oct. 6, 1906.
- 1210 19,130 of 1906. Smelting process.—**R. W. E. MacIvor** and **M. Fradd**, London.
"In treating complex sulphides, throwing the roasted ores into calcium chloride and then passing sulphurous acid into the mixture."—E. & M. J.
- 1211 24,905 of 1906. Extraction of metals from zinc-lead sulphide ores.—**J. C. Fernau**, Nelson, B. C. Nov. 6, 1906.
"Molten iron is caused to circulate between an air-tight working chamber and a superheating chamber, and zinc-lead sulphide ores are introduced into the working chamber. The zinc is volatilized, the vapors passing through incandescent carbon to a condenser. The lead settles to the bottom of the molten iron in the working chamber and is tapped off, and iron sulphide is also withdrawn, from time to time, from the surface of the molten metal."—J. S. C. I.
- 1212 4,563 of 1909. Means for treating fumes from zinc retorts.—**H. E. Howard** and **G. Hadley**, Halesowen, England. Feb. 24, 1909.
A carbon filter for attachment to the open end of the zinc condenser.
- 1213 9,955 of 1909. Filter for zinc distillation.—**C. S. Brand**.
Retort filter for catching volatilized lead.
—Described in *Min. Mag.*, vol. 2, p. 457. June, 1910.
- 1214 22,704 of 1909. Nozzle for catching zinc fume that escapes from the condenser.—**Wm. Rees**, Swansea, England.
—Described in *Min. Mag.*, vol. 4, p. 58. Jan., 1911.
- 1215 3,951 of 1912. Process for the treatment of sulphide ores, tailings and other residues containing lead and zinc.—**A. Richards**, London.
"A mixture of the material with a reducing agent and a small quantity of sodium chloride or a suitable bromine-containing substance is subjected to a temperature sufficient to expel the zinc or lead, or both, as haloid compounds."—J. S. C. I.
- 1216 732 of 1913. Improvements in, or relating to, apparatus for the continuous removal of the residues from the reduction of zinc ores in vertical retorts.—**R. Roitzheim**, Cologne, and **W. Remy**, Aix-la-Chapelle.
- 1217 1,701 of 1913. An improved process and apparatus for the condensation of vapors of volatile metals, especially zinc vapor.—**F. G. W. Timm**, Hamburg, Germany.
Patented also in France, No. 454,497.

- 1218 17,648 of 1913. Method of manufacture of zinc from poor zinc-ore and tailings.—**F. C. Beauchamp**.
—Described in Min. Jour., vol. 100, p. 269. Mar. 15, 1913.
- 1219 1,930 of 1915. Retort furnaces for the recovery of volatile metals such as zinc.—**E. Gellbach**, Hohenlohehuette.
The regenerative heating system is employed, but the direction of the flame is maintained constant in the combustion chamber of the retort furnace in order to insure uniform heating.
- 1220 8,265 of 1915. Zinc smelting furnace.—**E. Ruck**, Swansea.
—Described in Jour. Soc. Chem. Ind., vol. 35, p. 1066. October 31, 1916.
- 1221 9,009 of 1915. Recovery of zinc.—**F. W. Highfield**, Whitchurch-on-Thames, Oxford.
—Described in Jour. Soc. Chem. Ind., vol. 35, p. 850, Aug., 1916.
- 1222 115,409. Extraction of zinc.—**E. H. Shortman, jr.**, and **New Delaville Spelter Co., Ltd.**, Birmingham. Appl. No. 10,385 of 1917.
“A zinc retort is connected with a condenser of large capacity by a passage provided with a lead-intercepting and filtering device.”—J. S. C. I.
- 1223 122,566. Increasing the production of zinc dust from spelter retorts.—**C. W.** and **C. Crocker**, Irvine, England. Appl. No. 7,025 of 1918.
“A set of baffles, not in alignment, mounted on a frame is inserted in the prolong used in connection with a zinc distillation retort, to facilitate the deposition of zinc dust.”—J. S. C. I.
- 1223a 122,688. Metallurgy of zinc.—**J. Armstrong**, London. Appl. No. 1,603 of 1918.
“Oxidized zinc ore is comminuted with bituminous coal, the mixture subjected to a low temperature coking process out of contact with air, and the resulting mass crushed and charged continuously into vertical tubular retorts formed in three sections, the middle one of which is heated and constitutes the reduction retort. This section is made of pure silica and corundum.”—J. S. C. I.

France

- 1224 339,752. Recovery of zinc and lead from ores.—**Miller**. June, 1904.
Broken-Hill refractory ores are mixed with fine silicide and with tar, and eventually with lime, if silver is present. The mixture is ground, placed in a retort and heated slowly. Sb and Bi distil first, then Zn. Pb and Ag remain as metal in the retort.

- 1225 348,733. Treatment of zinc ores.—**E. Demenge.** Dec. 9, 1904.
 "The ores are smelted in a water-jacketed cupola furnace, using a strong blast. The volatilized lead and the precious metals are recovered in the metallic state. Zinc is volatilized and drawn off by a fan through a series of cooling and condensing chambers where it is deposited as oxide."—J. S. C. I.
- 1226 363,036. Manufacture of zinc.—**R. Fritsch and E. Nonnast.** Feb. 6, 1906.
 "Before being distilled, the mixture of zinciferous mineral and carbonaceous material is first molded into blocks corresponding with the cross-section of the retort. This facilitates charging the retorts, and enables 35% to 40% more material to be distilled in one operation."—J. S. C. I.
- 1227 366,380. Retort, muffle, etc., for the reduction of zinc ores and other purposes.—**D. Delville et Cie. des Metaux et Prod. Chim. d'Overpelt.** May 18, 1906.
 "The retort is provided on the outside with a number of horizontal channels for the better utilization and transmission of the heat supplied."—J. S. C. I.
- 1228 446,576. Treatment of complex ores of zinc, lead, silver, gold and copper.—**A. J. and R. J. Merle.** Oct. 4, 1911.
 "The crushed ore is melted with suitable fluxes in a furnace provided with powerful aspirators. The lead and zinc are volatilized and thus separated from the other metals. By injecting a solution of glucose into the aspirators, the lead and zinc salts contained in the gases from the furnace are retained. The glucose solution is run into settling tanks where the insoluble lead salts separate as mud. The decanted solution is used again and again, until sufficiently rich in zinc salts, which are then precipitated by the addition of lime."—J. S. C. I.
- 1229 477,653. Process for the separation of lead and zinc.—**J. Babe.** June 24, 1914.
 Roasted ores containing lead and zinc are intimately mixed with finely powdered sulphur and carbon, and heated to 800° to 900° C., whereby lead sulphide is formed and volatilized, leaving the zinc as oxide. Ores containing the metals as sulphides are heated directly with carbon, without roasting or addition of sulphur.
 —Described in Jour. Soc. Chem. Ind., vol. 35, pp. 606-7. May 31, 1916.
- 1230 478,942. Condenser for vapors of lead and zinc.—**Soc. Anon. Metallurgique "Procedes de Laval".** June 7, 1915.
 —Described in Jour. Soc. Chem. Ind., vol. 35, pp. 1118-19. Nov. 15, 1916.
- 1231 479,039. Process for the treatment of low-grade, complex ores.—**H. E. L. Fievet.** June 15, 1915.
 Low-grade ores containing, for example, lead, zinc, arsenic, antimony, and precious metals, are mixed with oxide and sulphide ores of iron and a little copper, and the mixture smelted with iron slag

in a water-jacketed furnace, to produce a matte containing all the metals. The matte is tapped into a converter and "blown" in the presence of powdered coke to eliminate the more volatile metals, which are recovered as oxides or sulphates, leaving a matte rich in copper and containing the precious metals.

—Described in Jour. Soc. Chem. Ind., vol. 35, p. 1119. Nov. 15, 1916.

Germany

1232 107,247. Muffle furnace for distilling zinc, cadmium and the like.—**Carl Francisci**, Silesia. April, 1899.
—Described in Zeits. f. angewandte Chem., vol. 13, pp. 20-21. Jan. 2, 1900.

1233 117,614. Zinc smelting furnace with separate smelting and reduction chambers.—**Amedie Sebillot**, Paris. Jan., 1900.
—Described in Zeits. f. angewandte Chem., vol. 14, pp. 296-97. Mar. 19, 1901.

1234 137,004. Zinc distillation with simultaneous recovery of earth-alkali-sulphides.—**Henri M. Taquet**, Argenteuil, France. Mar. 21, 1901.
—Described in Zeits. f. angewandte Chem., vol. 15, p. 1227. Nov. 25, 1902.

1235 139,293. Smelting muffle residues of zinc furnaces.—**Adolf Savelsberg**, Ramsbeck, Germany. Apr. 3, 1902.

1236 140,554. Zinc smelting in a shaft furnace.—**Paul Schmieder**, Lipine, Silesia, Germany. Mar. 26, 1902.
—Described in Zeits. f. angewandte Chem., vol. 16, pp. 683-84. July 14, 1903.

1237 154,695. Process for the recovery from their sulphides of zinc, lead, and other metals having a slighter affinity for sulphur than has copper.—**Antoine H. Imbert**, Nov. 15, 1903.

1238 156,342. Muffle for the distillation of zinc and cadmium.—**O. Unger**. July 31, 1903.
"The furnace consists of two or more thin-walled muffles fitting one within the other, with, if necessary, spaces between. Strains during heating and cooling, and the formation of cracks are thus avoided."—J. S. C. I.

1239 165,243. Refining zinc and other metals by continuous distillation.—**Jacob Callman** and **Rudolph Bormann**, Berlin. Mar. 21, 1905.
—Described in Zeits. f. angewandte Chem., vol. 19, p. 1619. Sept. 21, 1906.

- 1240 169,612. Process for the recovery of zinc and other volatile metals in the shaft furnace.—**Hermann Mehner**, Berlin. Jan. 1, 1904.
—Described in Zeits. f. angewandte Chem., vol. 20, p. 159. Jan. 25, 1907.
- 1241 173,103. Process for removing zinc from burnt pyrites, and for utilizing the pyrites for the production of iron by smelting.—**Elektrische Zinkwerke G. m. b. H.** Mar. 20, 1904.
The pyrites is treated in a reverberatory furnace with two hearths, being heated in presence of a reducing agent to the volatilizing temperature of zinc, and finally to the fusing point.
- 1242 180,981. Process for working up zinciferous materials, simultaneously using the zinc and carbon content of the smelter residues.—**Gustav Stolzenwald**, Ploest, Roumania. Nov. 8, 1905.
- 1243 195,793. Recovery of zinc, lead, and the like, from their sulphide ores by precipitation with iron, copper, and the like.—**Antoine H. Imbert**. May 11, 1906.
—Described in Zeits. f. angewandte Chem., vol. 21, p. 1243. June 5, 1908.
- 1244 207,019. Process for the recovery of zinc from zinciferous lead and other low-grade zinc alloys.—**D. Coda**. June 21, 1907.
"An alloy of copper, or of copper and aluminium with lead is added to the fused alloy containing zinc, in order to concentrate the zinc dross which is practically free from silver and can be distilled."
—J. S. C. I.
- 1245 212,890. Apparatus for charging retorts of zinc and other metallurgical furnaces.—**Emile Dor-Delattre**, Budel, Holland. July 13, 1907.
—Described, with diag., in Zeits. f. angewandte Chem., vol. 22, p. 2297. Nov. 19, 1909.
- 1246 212,897. Process for recovery of zinc from ores and smelter products, especially from zinc sulphide ores containing copper, by adding chloride of an alkali or earth alkali, and smelting.—**Emil Vu'gner**, Paris. Oct. 28, 1906.
- 1247 218,408. Recovery of zinc from its oxide or sulphide ores, or from a mixture of both, precipitating by means of metal, and using an iron-bearing solvent (Fe_2O_3) for the zinc ore.—**Imbert Process Co.**, New York.
—Described in Zeits. f. angewandte Chem., vol. 23, pp. 806-7. Apr. 29, 1910.

- 1248 231,694. Process for the recovery of zinc by reduction in the muffle.—**Akt'en-Gesellschaft f. Bergbau, Ble- und Zinkfabrikation**, Aix-la-Chapelle. Jan. 28, 1908.
—Described in Zeits. f. angewandte Chem., vol. 24, p. 611. Mar. 31, 1911.
- 1249 232,097. Process for the treatment of mixed lead-zinc sulphides, with simultaneous recovery of the metallic lead and zinc oxide.—**Wilhelm Witter**, Hamburg. Sept. 17, 1908.
See also 240,365, below.
—Described in Zeits. f. angewandte Chem., vol. 24, pp. 715-16. Apr. 14, 1911.
- 1250 238,292. Working up low-grade zinc ores, especially calamine.—**Gilbert Dantin**, Lyons, France. Oct. 21, 1909.
—Described in Zeits. f. angewandte Chem., vol. 24, p. 1980. Oct. 13, 1909.
- 1251 240,365. Treatment of mixed lead-zinc sulphides, with simultaneous recovery of metallic lead and zinc oxide, the oxide ores being reduced with iron.—**Wilhelm Witter**, Hamburg, Germany. Oct. 19, 1909.
Modification of 232,097, above.
—Described in Zeits. f. angewandte Chem., vol. 24, p. 2275. Nov. 24, 1911.
- 1252 244,893. Process for the recovery of metallic zinc or zinc dust from sulphide materials such as blende, roasted zinc sulphide or zinc ore intimately mixed with gangue, by heating with hydrogen or with hydrogenous gases and compounds.—**Kurt Friederich**, Breslau, Germany. July 24, 1910.
—Described in Zeits. f. angewandte Chem., vol. 25, pp. 981-82. May 10, 1912.
- 1253 245,503. Process for the distillation of zinc, using a haloid salt.—**Central Zinc Co., Ltd.**, Seaton Carew, England. Dec. 21, 1910.
—Described in Zeits. f. angewandte Chem., vol. 25, p. 982. May 10, 1912.
- 1254 245,681. Process for the recovery of zinc by distillation.—**H. Specketer**, Griesheim, Germany. July 27, 1909.
—Described in Zeits. f. angewandte Chem., vol. 25, p. 982. May 10, 1912.
- 1255 248,750. Process for the recovery of metallic zinc from zinc dust.—**Charles Thierry**. April 2, 1911.

- Described in *Zeits. f. angewante Chem.*, vol. 25, p. 1871. Sept. 6, 1912.
- 1256 253,640. Process and apparatus for recovery of zinc in a shaft furnace with blast feed below.—**Antoine B. Pescatore**, London, England. June 8, 1911.
—Described in *Zeits. f. angewandte Chem.*, vol. 26, pt. II, p. 56. Jan. 28, 1913.
- 1257 255,918. Distillation furnace with vertical muffles or other suitable reduction-chambers, for the recovery of zinc or other volatile metals.—**Rheinisch-Nassauische Bergwerks- und Huetten-Akt.-Gesell.**, Stolberg, Germany. Feb. 11, 1912.
—Described in *Zeits. f. angewandte Chem.*, vol. 26, pt. II, p. 128. Feb. 25, 1913.
- 1258 256,083. Process for obtaining metals such as zinc, lead, etc., from their compounds with oxygen or sulphur.—**R. von Zelewski**. May 19, 1912.
"Heating with carbides, a chloride compound of an alkali or alkaline-earth metal being added to facilitate the reaction."—J. S. C. I.
- 1259 260,749. Process for the distillation of zinc and other volatile metals from ores or the like by introducing an air current, in a discontinuously working furnace, through an ignited mixture of the ore or smelting product with fuel, and allowing the residue to sinter together.—**Wilhelm Troeller**, Frankfurt-am-Main, Germany. Dec. 11, 1909.
—Described in *Zeits. f. angewandte Chem.*, vol. 26, pt. II, pp. 440-41. July 22, 1913.
- 1260 265,061. Process for the condensation of zinc vapors.—**F. C. W. Timm**, Hamburg. Feb. 21, 1912.
—Abstract. *Zeits. f. angewandte Chem.*, vol. 26, pt. II, p. 687. Nov. 18, 1913.
- 1261 265,805. Apparatus for the condensation of zinc vapors which are obtained by the reduction of pure zinc oxide in suitable retorts.—**Pierre Ferrere**, Paris. Mar. 7, 1912.
—Described, with diag., in *Zeits. f. angewandte Chem.*, vol. 26, pt. II, pp. 687-88. Nov. 18, 1913.
- 1262 268,028. Removable condenser for zinc distillation furnace.—**Carl Reichmann**, Kattowitz, Silesia. Dec. 4, 1912.
Consists of an iron jacket lined with asbestos.
- 1263 271,827. Process and apparatus for liquefaction of zinc vapor in the zinc furnace.—**Charles V. Thierry**, Paris. July 20, 1912.

- Described in *Zeits. f. angewandte Chem.*, vol. 27, pt. II, p. 258. Apr. 17, 1914.
- 1264 276,292. Distillation furnace for zinc and the like, rotating upon a horizontal axis.—**Hermann Hantelmann**, Merseburg, Germany. Mar. 28, 1913.
—Described, with diagr., in *Zeits. f. angewandte Chem.* vol. 27, pt. II, p. 522. Sept. 4, 1914.
- 1265 286,535. Method and apparatus for removing hot residues from muffles.—**E. Gellbach** and **M. Matt**, Hohenloehuetten, Silesia.
The residues are removed by jets of air and water, assisted by scrapers attached to the outer tube of the device through which the water and air are introduced.
—Described in *Jour. Soc. Chem. Ind.*, vol. 35, p. 185. Feb. 15, 1916.
- 1266 287,122. Manufacture of zinc muffles.—**Celludin Co.**, Berlin.
The muffle is made from a mixture containing an amount of zirconia equal to from 1% to 10% of the whole. A suitable mixture is composed of 33.3% clay, 1 to 10% zirconia, and "grog" (burnt fire-clay).
—Described in *Jour. Soc. Chem. Ind.*, vol. 35, p. 185. Feb. 15, 1916.
- 1267 289,720. Process for obtaining zinc.—**E. Fleischer**, Dresden, and **Bunzlauer Werke Lengersdorf und Co.**, Bunzlau, Germany. June 7, 1912.
A mixture of ore and reducing agent (carbon) is treated in externally heated retorts with reducing gases (e. g., a mixture of carbon monoxide and nitrogen), the temperature of which is at least 1000°C., and the gases from the retorts are led through a condenser maintained at a temperature between the melting point and vaporization point of zinc, e. g., at 500° to 600° C.
—Described in *Jour. Soc. Chem. Ind.*, vol. 35, p. 427. Apr. 15, 1916.
- 1268 291,043. Process for improving the durability of muffles for distillation of zinc.—**A. Zavelberg**, Hohenloehuetten, Silesia. April 3, 1914.
A pair of muffles, one fitting loosely inside the other, with the intermediate space packed with finely ground silica or washed sea-sand.
—Described in *Jour. Soc. Chem. Ind.*, vol. 35, p. 641. June 15, 1916.
- 1269 293,344. Shaft furnace for metallurgical purposes, e. g. for the recovery of zinc.—**Coswiger Braunkohlen-Werke Ges. m. b. H.**, Coswig. Feb. 16, 1915.

—Described in Jour. Soc. Chem. Ind., vol. 35, p. 1066. Oct. 31, 1916.

1270 294,287. Process for separating zinc from alloys containing it.—**G. Heinecker**, Breslau. Feb. 5, 1916.

—Described in Jour. Soc. Chem. Ind., vol. 35, p. 1161. Nov. 30, 1916.

1270a 306,725. Production of zinc of high purity from impure metal and alloys in vacuo.—**E. Hertcr**, Berlin. July 6, 1913.

"In the vacuum distillation of zinc the condensed liquid metal is continuously drawn off, without impairing the vacuum, by maintaining a column of the liquid metal of sufficient height to balance the atmospheric pressure."—J. S. C. I.

1270b 308,156. Furnace for refining zinc.—**W. Nestmann**, Coeln-kalk, Germany. Sept. 27, 1917.

"The floor of the furnace slopes toward a lateral taphole leading into a well where the lead separates out."—J. S. C. I.



FULTON'S ELECTRIC FURNACE

Retort and condenser with top connection. Condenser to the right. Note the carbon monoxide flame.



FULTON'S ELECTRIC FURNACE
Briquettes, 9 1/4 inches diameter, 22 inches long

ELECTRO-THERMIC SMELTING

Bibliography

- 1271 Bibliography on the development of the electric furnace.—**Adolph Minet.** Faraday Soc., Trans., vol. 2, pp. 25-28. May, 1906.

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- 1272 A brief description of working models of electric furnaces, by the Philadelphia Electric Co. Amer. Electrochem. Soc., Trans., vol. 11, pp. 411-14. 1907.
Colby induction, Kryptol, arc, arc and resistance, resistance furnaces.
- 1273 A closed electric furnace for reducing and distilling metals from their ores.—**Edward R. Taylor.** diagr. Amer. Electrochem. Soc., Trans., vol. 11, pp. 295-301. 1907.
- 1274 Combined fuel and electrically heated refining furnace, diagr. Met. & Chem. Eng., vol. 16, pp. 531-32. May 1, 1917.
Helfenstein's Patent 1,220,111. "In order to overcome the necessity for inserting electrodes each time the electrical heating is to be used, a long horizontal tubular furnace is used with a metal bath which is shallow relative to the diameter of the furnace.
- 1275 Comparison between electric and fuel furnaces.—**Francis Louvrier.** Mex. Min. Jour., vol. 17, pp. 427-29. Sept., 1913.
—Abstract. Met. & Chem. Eng., vol. 11, pp. 652-54. Nov., 1913.
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Electric smelting of zinc

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FULTON'S ELECTRIC FURNACE

Charge on right base; top graphite connectors not yet placed; condenser with top connection on left.



FULTON'S ELECTRIC FURNACE

A charge of 12 columns, 36 briquettes, weight 3160 lbs., containing 1700 lbs. of ore, set up on base ready for distillation.

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- 1363 Gewinnung von Zink durch Niederschlagsarbeit im elektrischen Ofen. Metallurgie, vol. 6, p. 637. Oct. 8, 1909.
German Patent 210,030, by Cote and Pierron, for zinc extraction by precipitation in the electric furnace.
- 1364 The Gin electric furnace for zinc smelting. diagr. Eng. & Min. Jour., vol. 85, p. 1153. June 6, 1908.
Induction furnace for distillation. French Patent 382,872.
- 1365 The Imbert process.—**E. G. Spilsbury**. Min. & Sci. Press, vol. 92, p. 434. June 30, 1906.
- 1366 Johnson continuous electric zinc furnace. illus. Iron Age, vol. 89, pp. 1082-83. May 2, 1912.
Metallurgy, construction and operation.
- 1367 The Johnson electric zinc furnace.—**Joseph W. Richards**. illus., diagr. Amer. Electrochem. Soc., Trans., vol. 19, pp. 311-16. 1911.
—Abstract. illus. Met. & Chem. Eng., vol. 9, pp. 264-65. May, 1911.
—Abstract. diagr. Min. Mag., vol. 5, p. 310. Oct., 1911.
- 1368 The Johnson electric zinc process.—**Woolsey McA. Johnson**. Min. Wld., vol. 40, pp. 48-49. Jan. 10, 1914.
Discussion of comparative costs.
- 1369 Kontinuierliche Gewinnung von Zink in fluessigem Zustande in elektrischen Oefen mit beheiztem Kondensationsraum. diagr. Metallurgie, vol. 5, pp. 589-90. Oct. 8, 1908.
Cote & Pierron's German Patent 200,668, for the continuous extraction of zinc in fluid state in electric furnaces with heated condensation chambers.
- 1370 Manufacture of pure spelter.—**F. Juretzka**. Chem. Zeitg., vol. 40, pp. 885-86, 894-96. 1916.
Pure spelter (99.7—99.9% Zn) is obtained from refined metal (Pb 1, Fe .03%) by distillation at low temperatures. Electrically heated furnaces are much more advantages for this purpose than the ordinary gas-heated muffle furnaces. A central condensing system is more economical than muffles fitted with condensers, and allows of a reduced pressure.—J. S. C. I. In German.
- 1370a Métallurgie électrothermique du zinc.—**J. Escard**. Génie Civil, vol. 73, pp. 124-27, 141-46, 168-71. Aug. 17, 24, 31, 1918.

- 1371 The metallurgy of zinc. Eng. & Min. Jour., vol. 92, pp. 385-86. Aug. 26, 1911.
- 1372 The metallurgy of zinc; the new electrolytic and electrothermic methods.—**R. Sylvany**. Metal Industry, vol. 7, pp. 330-32, 362-64, 404-5. 1915.
- 1373 Neuerungen in der Elektrometallurgie des Zinks und des Kadmiums.—**Franz Peters**. diagr. Glueckauf, vol. 45, pp. 1401-13. Sept. 25, 1909.
 Metal losses may be reduced; cheap power necessary; reduction of blende with iron requires high temperature; use of carbon. Describes several furnaces, especially the Cote-Pierron.
 —Abstract: Recent advances in the electrometallurgy of zinc. diagr. Eng. & Min. Jour., vol. 89, pp. 1017-19. May 14, 1910.
 —Abstract. Electrochem. & Met. Ind., vol. 6, p. 196. May, 1908.
- 1374 A new electric resistance furnace.—**Francis A. J. Fitzgerald**. illus., diagr. Amer. Electrochem. Soc., Trans., vol. 19, pp. 273-84. 1911.
 Detailed description of Imbert process. Much the same paper as item 1312. See also item 1378.
 —Same. illus., diagr. Met. & Chem. Eng., vol. 9, pp. 259-62. May, 1911.
- 1375 A new electric zinc smelting process. diagr. Met. & Chem. Eng., vol. 16, pp. 158-59. Feb. 1, 1917.
 C. H. Fulton's Patent 1,213,180. The charge is the resistor. It is in the form of briquettes which preserve their form and volume during distillation.
 —Same: Fulton's electric zinc furnace. diagr. Min. Mag., vol. 16, p. 220. April, 1917.
- 1376 A new resistor furnace.—**Francis A. J. Fitzgerald**. illus. Met. & Chem. Eng., vol. 8, p. 317. June, 1910.
 "Specially designed for zinc smelting."
 —Abstract. Jour. Inst. Metals, vol. 4, p. 294. 1910.
- 1377 A new type of electric furnace for the reduction of ores.—**Francis Louvrier**. diagr. Met. & Chem. Eng., vol. 11, pp. 710-13. Dec., 1913.
 About half the paper discusses zinc ore reduction. In the author's furnace "the proportion of blue powder is not to exceed 3 per cent of the metal."
 —Abstract. Jour. Inst. Metals, vol. 11, pp. 335-36. 1914.
- 1378 Note on an unsuccessful furnace experiment.—**Francis A. J. Fitzgerald**. Amer. Electrochem. Soc., Trans., vol. 20, pp. 281-86. 1911.

Owing to excessive heat losses, disappointing results were obtained from the furnace described above (item 1312 and 1374).

- 1379 Notes on electric zinc smelting.—**Woolsey McA. Johnson.** illus. *Met. & Chem. Eng.*, vol. 10, pp. 537-38. Sept., 1912.
- 1380 Nuevo beneficio electrico de los minerales de zinc.—**Fran-cis Louvrier.** *Mex. Min. Jour.*, vol. 8, no. 4, pp. 35-36. April, 1909.
Author's electric smelting furnace.
- 1381 Possible applications of the electric furnace to Western metallurgy.—**Dorsey A. Lyon and Robert M. Keeney.** *Amer. Electrochem. Soc., Trans.*, vol. 24, pp. 119-66. 1913.
Electric zinc smelting; smelting at Trollhatten, Sweden; experi-ments at McGill University; experiments of Johnson; electric smelt-ing of zinc sulphide ores with iron as a desulphurizing agent.
—Abstract. *Met. & Chem. Eng.*, vol. 11, pp. 577-81. Oct., 1913.
- 1382 Preventing blue powder in the electric reduction of zinc ores.—**Woolsey McA. Johnson.** *Met. & Chem. Eng.*, vol. 13, p. 763. Oct. 15, 1915.
Author's Patent 1,150,271. "The ores are first calcined, at a roasting temperature of 950° C., with conditions such that sulphates other than those of barium, lead and calcium are decomposed....."
- 1383 Recent advances in the construction of electric furnaces for the production of pig iron, steel and zinc.—**Eugene Haanel.** *Canada, Mines Branch, Bull.* 3. 1910.
Discusses the Cote-Pierron furnace.
—Abstract: Electric smelting of zinc ore. *diagr. Min. Mag.*, vol. 4, p. 65. Jan., 1911.
- 1384 Recent development of the Cote and Pierron electric zinc-smelting process. *Met. & Chem. Eng.*, vol. 18, p. 17. Jan. 1, 1918.
"Interesting and hitherto unpublished details." Abstract of an article by G. Flusin in *Bulletin Technique de la Suisse Romande*, vol. 43, p. 233. Nov. 17, 1917.
—Abstract, in German. *Metall u. Erz*, vol. 15, pp. 147-48. May 8, 1918.
- 1385 Reducibility of metallic oxides as affected by heat treat-ment.—**Woolsey McA. Johnson.** *diagr. Amer. Inst. Min. Eng., Trans.*, vol. 47, pp. 219-32. 1913.
Ease of reduction depends largely on the way the ores have been prepared.
—Same. *Amer. Inst. Min. Eng., Bull.* 79, pp. 1137-45. July, 1913.
—Abstract. *Met. & Chem. Eng.*, vol. 11, p. 529. Sept. 1913.

- 1386 Reduction of zinc oxide. diagr. Met. & Chem Eng., vol. 11, p. 346. June, 1913.
Burgess' Patent 1,059,342. The zinc ore and the carbon reducing agent are kept separate, and the zinc oxide volatilized in an electric furnace.
- 1387 Reduction of zinc oxide in an electric furnace. diagr. Met. & Chem. Eng., vol. 13, p. 817. Nov. 1, 1915.
Highfield's Patent 1,153,786.
- 1388 Scandinavian electric zinc smelting. Eng. & Min. Jour., vol. 96, p. 1030. Nov. 29, 1913.
- 1389 The smelting of dross in the electric furnace.—**Raymond S. Wile.** illus. Min. Wld., vol. 42, pp. 501-4. Mar. 13, 1915.
"For the purpose of accelerating and completely extracting the zinc from the charge, which is in a molten condition, reaction agents in the form of strong bases are added exclusively, besides the normal reducing agents, which reaction agents drive off the zinc oxide as such from the complex silicates."
- 1390 Smelting zinc in an electric furnace.—**F. L. Clerc.** Met. & Chem. Eng., vol. 11, pp. 428-29. Aug., 1913.
Comment on Louvrier's article (item 1299) with additional data. Suggests that blue powder is not due to oxidation, that the position of the electrodes may not be responsible for rapid cooling of the zinc, etc. See also item 1342.
- 1391 Some present-day metallurgical problems.—**Dorsey A. Lyon.** Jour. Franklin Inst., vol. 177, pp. 187-222. Feb., 1914.
Five pages on electric zinc smelting.
—Abstract: Electrochemistry of zinc. Jour. Inst. Metals, vol. 11, pp. 320-21. 1914.
—Abstract. Mex. Min. Jour., vol. 19, pp. 257-60. Oct., 1914.
- 1392 Thermo-electric determinations of the reduction temperature of zinc oxide.—**Woolsey McA. Johnson.** diagr. Amer. Electrochem. Soc., Trans., vol. 5, pp. 211-20. 1904.
—Abstract: Reduction temperature of zinc oxide. diagr. Electrochem. & Met. Ind., vol. 2, pp. 185-87. May, 1904.
—Abstract. Eng. & Min. Jour., vol. 77, p. 1045. June 30, 1904.
—Abstract. Mineral Industry, vol. 12, pp. 363-64. 1903.
- 1393 Treating zinc bearing materials. diagr. Met. & Chem. Eng., vol. 13, p. 504-5. Aug., 1915.
W. McA. Johnson's Patent 1,146,075. The zinc of zincy slags is reduced with iron, the zinc being subsequently volatilized and condensed.

- 1394** Treatment of British Columbia zinc ores. *Canad. Min. Jour.*, vol. 35, pp. 333-36. May 15, 1914.
Discussion of the investigations of the Mines Branch, especially in regard to electric smelting.
- 1395** Treatment of ferruginous zinc blende. *Electrochem. & Met. Ind.*, vol. 5, p. 470. Nov., 1907.
W. McA. Johnson's Patent 868,345.
- 1396** Treatment of zinc-lead ores. *diagr. Electrochem. & Met. Ind.*, vol. 4, pp. 503-4. Dec., 1906.
Snyder's Patent 834,644.
- 1397** Treatment of zinc ore in electric fnaces. *Met. & Chem. Eng.*, vol. 14, p. 711. June 15, 1916.
Berglund's Patent 1,160,244. To prevent the formation of crusts of slag, etc., near the tap-hole, there are added at intervals certain easily fusible materials that will combine with and melt the crust.
- 1398** Ueber die elektrothermische Zinkgewinnung.—**H. Nathusius.** *diagr. Metall u. Erz.*, vol. 15, pp. 87-93, 108-111. Mar. 22, Apr. 8, 1918.
Attempts hitherto have been failures because electric furnaces have not been constructed to solve the problem of the condensation of the zinc vapor. The author has designed a furnace which is described in detail.
—Abstract: Electrothermal smelting of zinc. *Jour. Soc. Chem. Ind.*, vol. 36, p. 376A. July 15, 1918.
—Abstract, in German. *Zeits. f. angewandte Chem.*, vol. 31, p. 255. Aug. 9, 1918.
- 1399** Ueber die Verarbeitung von sulfidischen oder oxydischen Zinkerzen im elektrischen Ofen.—**Wm. Borchers.** *Metal-lurgie*, vol. 9, pp. 153-54. Mar. 8, 1912.
Treatment of sulphides or oxides of zinc in the electric furnace.
—Abstract. *Zeits. f. angewandte Chem.*, vol. 25, p. 1705. Aug. 16, 1912.
- 1400** Ununterbrochenen Destillation von Zink. *diagr. Metal-lurgie*, vol. 1, p. 109. Mar. 22, 1904.
De Laval's German Patent 148,439. Electric furnace for continuous distillation of zinc. The zinc ore is mixed with coal dust, and distills at a high temperature.
- 1401** Verfahren, die bei Zinkgewinnung im elektrischen Ofen abziehenden Gase zu reduzieren und zu reinigen. *diagr. Metall u. Erz.*, vol. 12, p. 253. June 22, 1915.
German Patent 284,866, by Trollhattan Elektrothermiska Aktiebolag, for reducing and refining vapors drawn off in electric zinc smelting.

- 1402 Verfahren und Ofen zur elektrothermischen Gewinnung fluechtiger metalle, insbesondere von Zink, durch Widerstandsheizung. Metall u. Erz, vol. 12, p. 104. Mar. 8, 1915.
German Patent 282,141, by Max Breslauer, for a furnace and process for electrothermic recovery of volatile metals, especially zinc, by heat resistance.
- 1403 Verfahren und Ofen zur Verfluessigung der Zinkdaempfe in Zinkoefen. diagr. Metall u. Erz, vol. 11, pp. 322-23. May 8, 1914.
Thierry's German Patent 271,827, for an electric furnace, and process for condensing the zinc vapors.
- 1404 Verfahren zur Darstellung von Zink und anderen aehnlich sich verhaltenden Metallen im elektrischen Ofen unter Benutzung der Beschickung als Heizwiderstand und Ofen zur Ausuebung des Verfahrens. diagr. Zeits. f. Elektrochem., vol. 19, pp. 280-82. Mar. 15, 1913.
Specketer's Patent 1,099,211, for producing zinc and other similar metals in a rotating electric furnace, using the charge as a resistance.
- 1405 Verfahren zur Herstellung von Zink unter Verwendung eines flussigen Schlackenbades. diagr. Zeits. f. Elektrochem., vol. 20, pp. 165-66. Mar. 1, 1914.
Tharaldsen's German Patent 261,188. To prevent formation of flue dust, the charge is introduced beneath or in a slag solution.
- 1406 Vorrichtung zur kontinuierlichen Gewinnung von Zink in fluessigen zustand in elektrischen Oefen mit beheiztem Kondensationsraum. Metallurgie, vol. 6, p. 225. Apr. 8, 1909.
Cote and Pierron's German Patent 206,311 for continuous extraction of zinc in fluid state in an electric furnace with heated condensation chambers.
- 1407 Zinc and lead from complex sulphide ores. Electrochem. & Met. Ind., vol. 4, p. 34. Jan., 1906.
Imbert's Patent 807,271. "Based on the property of metallic copper to act as a very energetic desulphurizer toward most of the ordinary metals." See also item 1045.
- 1408 Zinc extraction in the electric furnace. Min. Jour. vol. 94, p. 811. Aug. 5, 1911.
Snyder electric furnace for reducing plombiferous zinc ores at Slocan, B. C.
- 1409 Zinc in the electric furnace. Electrochem. & Met. Ind., vol. 3, pp. 209-10. June, 1905.
- 1410 Zinc metallurgy. Min. Mag., vol. 5, pp. 252-54. Oct., 1911.
Editorial on F. W. Harbord's work at Trollhattan.

- 1411 Zinc smelting at Trollhattan; summary of a report by **F. W. Harbord**. Eng. & Min. Jour., vol. 93, pp. 314-15. Feb. 10, 1912.

Electric zinc smelting, under De Laval patents. "Statement of results, including cost and extraction of metals, and reference to the condensation of zinc as powder as the weak point of the process."

- 1412 Zinc smelting in the electric furnace.—**Woolsey McA. Johnson**. diagr. Eng. & Min. Jour., vol. 96, pp. 965-67, 1041. Nov. 22, 29, 1913.

"Discussion of differences between electric and fire-smelting processes, and between electric-furnace slags and ordinary retort slags."

- 1413 Zink in Form von Zinkoxyd zu gewinnen. Metallurgie, vol. 2, p. 583. Dec. 22, 1905.

K. Kaiser's German Patent 162,762 for electric smelting of zinc ores without the addition of a reducing agent.

- 1414 Zinkfuehrende sulfidische Erze. Metallurgie, vol. 1, p. 204. May 22, 1904.

Danckwardt's Patent 746,797 and 746,798.



FULTON'S ELECTRIC FURNACE

Retort lifted, showing charge red hot. Twelve columns of 9-inch briquettes; 3160 lbs. Zinc vapor ready to be discharged. Condenser to left with bottom connection.

PATENTS ON ELECTRIC ZINC SMELTING

United States

- 1415** 567,699. Electric smelting furnace.—**Joseph A. Vincent**, Philadelphia. Filed October 30, 1895. Issued September 15, 1896.

- 1416** 640,283. Electric Furnace.—**Francis E. Hatch**, Norway, Mich. Filed Mar. 4, 1899. Issued Jan. 2, 1900.

A process for smelting ore, metal or the like, which consists in heating a series of refractory electric conductors by the application of an electric current by subjecting said conductors to the effect of the said current in sequence, and placing said conductors, after being so heated, successively in contact with the material to be smelted, associated with a suitable reducing agent whereby said material is smelted, at the same time other conductors of the said series are being heated by the current. 6 claims.

- 1417** 643,254. Electric Furnace.—**Albert J. Peterson**, Notre Dame de Briancon, France. Filed Apr. 5, 1898. Issued Feb. 13, 1900.

In an electric oven, a chamber for the reception of the material to be reduced, an oven arranged below said chamber and having a flat hearth adapted to receive the reduced material, and two electrodes arranged in and having their upper surfaces level with the hearth of said oven, the upper flat surface of said electrodes adapted to be covered by and in contact with the reduced material and out of contact with the unreduced material, all arranged so that the reduced material on and between the electrodes is heated by the resistance it opposes to the passage of the current between the electrodes the circuit of which is completed by said reduced material and the unreduced material is heated and reduced by contact solely with the heated reduced material.

- 1418** 660,043. Electrical Furnace.—**Wilhelm Borchers**, Aix-la-Chapelle, Germany. Filed Dec. 22, 1898. Issued Oct. 16, 1900.

In an electric furnace, the combination of a furnace structure, a feed-chute for the material operated upon, two electrodes adjustably arranged in the furnace to form an arc, one of said electrodes being disposed between the feed-chute and the other electrode and gradually tapered to a point, and means for feeding the material from the chute in a mass gradually decreasing in cross-sectional area over and past the tapered electrode to the arc, substantially as and for the purpose specified.

- 1419** 705,651. Reduction of metals from their ores, etc., in electrically-heated furnaces.—**Ramon C. Contardo**, Sevres, France. Filed Dec. 1, 1897. Issued July 29, 1902.

The process of obtaining metal direct from the ore consisting in subjecting the lower end of a descending column of ore to a high temperature by a voltaic arc not in physical contact with the ore, and simultaneously causing a current of heated reducing-gas to flow upwardly through the column of ore. Patented also in England, No. 26,090 of 1902; In France, No. 334,103.

- 1420 716,008. Working zinc and substances containing silicic acid in electric furnaces.—**Alfred Dorsemagen**, Wesel, Germany. Filed Aug. 24, 1901. Issued Dec. 16, 1902.

A method of working a zinc-silicate ore consisting in preparing a charge of zinc silicate and carbon, then subjecting the charge to the action of an electric current sufficient to determine the reduction and volatilization of the zinc and the formation of carbide of silicon, and then suitably condensing the products of reduction and volatilization. Patented also in England, No. 16,122 of 1901; Germany, No. 182,534.

- 1421 736,611. Process of extracting zinc from its ores.—**Carl G. P. DeLaval**, Stockholm, Sweden. Filed November 15, 1901. Issued August 18, 1903.

The process of treating the ore of a volatilizable metal by radiant heat in an electric furnace which consists first in introducing said ore in comminuted state to form on the bottom of said furnace a pile or stack of gradually decreasing height sloping toward a source of electric heat, second, causing the non-volatile ingredient of said ore to melt and run down said surface so as to expose new layers of material constituting said stack to the action of said heat, and third, conducting the volatile metal vapors and generated gases by a separate outlet from said furnace and condensing said metal vapors.

- 1422 746,798. Process of recovering zinc from sulphide ores.—**Paul Danckwardt**, Deadwood, S. D. Filed August 15, 1903. Issued December 15, 1903.

The process of recovering and separating zinc and other valuable metals from ores or furnace product of a similar constitution, which consists in mixing the dry ore with a salt of an alkali metal, a carbide of any metal or a carbide-forming material, the carbide to be in excess over that required to bind all the oxygen of the charge in the form of carbon monoxide, mixing it further with fluxes for slagging of gangue and impurities of the ore, heating the mixture electrically under a heavy cover of carbon to prevent the formation of any carbon dioxide condensing the vapors of zinc and withdrawing the rest of the charge in a molten state, allowing the metals and matte to settle from the slag and sulphides of the alkali metal and calcium, dissolving the alkali sulphide in water, treating this solution with carbon dioxide, evaporating or crystallizing out the alkali carbonate and treating the escaping hydrogen sulphide for the recovery of the sulphur. 4 claims.

- 1423 750,753. Electric furnace.—**Ramon C. Contardo**, Sevres, France. Filed Aug. 24, 1900. Issued January 26, 1904.

- 1424 760,057. Process of electrically smelting materials.—**Alfred H. Cowles**, Cleveland, Ohio. Filed October 20, 1903. Issued May 17, 1904.

- 1425 768,054. Electric furnace.—**Carl P. G. De Laval**, Stockholm, Sweden. Filed May 8, 1903. Issued August 23, 1904.

- 1426 814,050. Electrical smelting process.—**Woolsey M. Johnson**, Iola, Kans. Filed May 24, 1904. Issued March 6, 1906.

The process of smelting zinc ores, which consists in interposing between a charge containing low-grade zinc ore and a furnace-wall, a charge containing high-grade zinc ore, thereby protecting said wall from the action of said low-grade ore. 13 claims.

- 1427 834,644. Process of treating ores.—Frederick T. Snyder, Oak Park, Ill. Filed June 21, 1905. Issued October 30, 1906.

The process of treating lead-zinc ores which consists in subjecting a body of such ores mixed with a reducing material, to a graduated heat sufficient to reduce the different metallic constituents thereof at different places in the ore body, collecting in a place of lower temperature the metal reduced at such temperature, progressively advancing the residue of the ore freed from such reduced metal to the place of increased temperature, and separately collecting the metal reduced at such higher temperature. 9 claims. See also item 1396.

- 1428 843,776. Electric furnace.—Edward R. Taylor, Pen Yan, N. Y. Filed May 1 51,902. Issued Feb. 12, 1907. 7 claims.
See also item 1330.

- 1429 843,777. Metallurgical process.—Edward R. Taylor, Penn Yan, N. Y. Filed May 27, 1902. Issued Feb. 12, 1907.

The metallurgical process which consists in feeding a suitable charge downwardly in proximity to the periphery of a furnace, and feeding portions of said charge inwardly through a surrounding body of the charge to a central reaction zone. 7 claims.

- 1430 859,132. Smelting process.—Frederick T. Snyder, Oak Park, Ills., assignor to Electric Metals Company, Chicago, Ills. Filed June 11, 1906. Issued July 2, 1907.

The process of treating lead-zinc sulphide ores which consists in subjecting the ore to an oxidizing roast, charging the furnace with roasted ore and carbon and fluxes adapted to form a slag at a temperature well above the boiling point of zinc, electrically developing heat in a limited zone in the furnace, sufficient to reduce the charge and keep the slag fluid, producing in the furnace slag, matte, metallic lead and a mixture of zinc and carbonic oxide allowing the carbonic oxide a restricted escape while condensing the zinc mixed therewith, progressively returning said condensed zinc to the zone of maximum heat and revaporizing said zinc, maintaining a flow of cooling fluid around the furnace wall, condensing the zinc vapor thereat in liquid form and drawing the liquid zinc from said walls and collecting the same. 27 claims.

—Described in Jour. Soc. Chem. Ind., vol. 26, p. 878-79. Aug. 15, 1907.

- 1431 859,133. Smelting furnace.—Frederick T. Snyder, Oak Park, Ills., assignor to Electric Metals Company, Chicago, Ills. Filed June 18, 1906. Issued July 2, 1907.

In an electric zinc-smelting furnace the combination with a base of a refractory material having a crucible therein, of a water-jacketed wall surmounting said base to form a furnace chamber, the top of said chamber being open, a bath of molten conducting material in said crucible, a carbon electrode extending down through the open

top of the furnace and making electrical connection with said molten bath, said furnace having an outlet for zinc opening off the furnace chamber at a point above said molten bath, said outlet being sealed against the passage of gas therethrough. 25 claims.

- 1432 859,134. Smelting process.—**Frederick T. Snyder**, Oak Park, Ills., assignor to Electric Metals Company, Chicago, Ills. Filed June 25, 1906. Issued July 2, 1907.

The process of treating ores of metals which are volatile at reduction, which consists in separately smelting successive isolated charges of such ore with reducing material and fluxes, heating a portion of each charge first to a temperature sufficient to drive off most of the gaseous compounds of the reducing agent, while maintaining a free surface of the charge sufficiently cool to condense the metallic vapor within the body of the charge, then further heating said charge as a whole to a degree sufficient to drive off substantially all of said volatile metal, fusing the residues to form a slag and superheating the slag, while collecting the vaporized metal. Patented also in England, No. 13,254 of 1907.

- 1433 859,135. Metallurgical process.—**Frederick T. Snyder**, Oak Park, Ills., assignor to Electric Metals Company, Chicago, Ills. Filed June 30, 1906. Issued July 2, 1907.

The process of treating lead zinc sulphide ore which consists in partially roasting the ore, then mixing it with gaseous coal, limestone and iron, and smelting the mixture in a crucible closed against the external air, producing molten lead which collects at the bottom of the crucible, a layer of matte above the lead, and molten slag above the matte; said matte serving to protect the lead from the action of the slag, the zinc being reduced and volatilized and diluted with large quantities of other gases from the materials of the charge; and condensing the zinc vapor in the form of zinc dust. 18 claims.

- 1434 859,136. Electric furnace.—**Frederick T. Snyder**, Oak Park, Ills., assignor to Electric Metals Co., Chicago, Ills. Filed June 30, 1906. Issued July 2, 1907. 14 claims.

- 1435 859,137. Electric furnace.—**Frederick T. Snyder**, Oak Park, Ills., assignor to Electric Metals Co., Chicago, Ills. Filed July 25, 1906. Issued July 2, 1907. Patented also in England, No. 19,712 of 1906; in France, No. 369,756.

See also item 1331.

—Described in Jour. Soc. Chem. Ind. Vol. 26, p. 878-79, Aug. 15, 1907.

- 1436 868,345. Process of treating ferruginous blende.—**Woolsey M. Johnson**, Iola, Kans. Filed Jan. 11, 1904. Issued Oct. 15, 1907.

The method of producing zinc, which consists in passing an electric current through a charge containing a compound of zinc and metallic iron, thereby heating the charge and reducing the compound of zinc. See also item 1395.

- 1437 904,263. Process of obtaining metals from their ores.—**Karl Kaiser**, Berlin, Germany. Filed June 22, 1906. Issued November 17, 1908.

The process of obtaining separately zinc and iron from pyrite residues and products of smelting works which consists in heating the raw products in an electric furnace, until the material melts, then forcing atmospheric air through the mass, until the metals are oxidized, then forcing carbon monoxide through the mass, leading off the zinc vapors and condensing same and running off the molten iron into molds.

- 1438** 920,473. Distillation furnace.—**Woolsey M. Johnson**, Hartford, Conn., assignor to The Continuous Zinc Furnace Company, Hartford, Conn. Filed May 8, 1906. Issued May 4, 1909.

An electric furnace comprising a furnace chamber having a vapor outlet, a permeable casing of refractory non-conductive material within said furnace chamber and spaced therefrom, electrodes disposed at opposite ends of said casing out of arcing relation, and means for feeding a charge to the interior of said casing. 5 claims.

—Described in Eng. & Min. Jour., vol. 88, p. 210. July 31, 1909.

- 1439** 933,133. Process of treating zinc ores.—**Frederick T. Snyder**, Oak Park, Ills., assignor to Electric Metals Company, Chicago, Ills. Filed June 23, 1905. Issued Sept. 7, 1909.

The continuous process of treating slag forming ores containing zinc and lead, which consists in pre-heating the ore with carbon to drive off gases and to start the process of reduction, then continuing the reduction in an electric furnace in the absence of air, at a temperature sufficient to volatilize the zinc without volatilizing the lead, said ore being mixed with carbon and with iron, silica and lime in such proportions as to form a slag at said temperature, said mixture being fed upon a bath of said slag in the furnace, an electric current being passed through said slag to maintain said temperature, collecting the reduced and volatilized zinc, removing the other products of smelting and adding further charges from time to time, including quantities of carbon in excess of the amount required for reduction without interrupting the operation or admitting air. Patented also in France, No. 369,756. See also item 1323.

—Described in Min. Mag., vol. 1, p. 220. Nov., 1900

- 1440** 933,843. Metallurgical condenser.—**Woolsey M. Johnson**, La Harpe, Kans., assignor to The Continuous Zinc Furnace Company, Hartford, Conn. Filed Nov. 30, 1903. Issued Sept. 14, 1909.

A zinc condenser provided with cooling means and with electrical heating means. 7 claims.

- 1441** 942,110. Electric furnace.—**Frederick T. Snyder**, Oak Park, Ills., assignor to Electric Metals Company, Chicago, Ills. Filed Sept. 25, 1906. Issued Dec. 7, 1909.

An electric furnace comprising a crucible base, a fluid-cooled wall surmounting said base, a tap opening being provided near the top of the crucible for drawing off the molten product therein, and a

body of heat-insulating material extending through said cooled wall above the level of said tap, and having an outlet opening there-through.

—Described in *Met. & Chem. Eng.*, vol. 8, p. 49. Jan., 1910.

- 1442 944,774. Electric furnace for the continuous extraction of zinc from its ores.—**Eugene F. Cote** and **Paul R. Pierron**, Lyon, France. Filed May 14, 1907. Issued Dec. 28, 1909.

In a reducing furnace, a condenser comprising an outer casing communicating with the furnace, an inner casing arranged within the outer casing, and spaced apart from the walls thereof, an electrode at each end of the inner casing, the electrodes forming the terminals of an electric circuit, the electrodes being movable toward and from each other, and non-fusible material arranged between the electrodes for the purpose set forth.

—Described in *Min. Mag.*, vol. 2, p. 204. Mar., 1910.

- 1443 946,688. Apparatus for production of zinc oxide.—**William Simm** and **Henry Simm**, Portico, near Prescott, England. Filed Oct. 1, 1907. Issued Jan. 18, 1910.

In an apparatus for producing zinc oxide electrically, the combination of a condensing chamber having suitable baffles, a hood connected therewith, and a suction fan for drawing the fumes into the hood and discharging them into the condenser, with an electrical furnace removably located beneath the hood and suitable detachable electric connections for the furnace, said connections including a choking coil. Patented also in England, No. 21,787 of 1906.

- 1444 950,877. Electric furnace.—**John Thomson**, New York, N. Y., assignor to Imbert Process Company, New York. Filed May 13, 1909. Issued March 1, 1910.

An electric furnace provided with a resistor of a constant length having a plurality of elements and means for preserving a substantially constant contact resistivity between the elements irrespective of expansion or contraction due to thermal changes. 14 claims.

- 1445 950,878. Furnace.—**John Thomson**, New York, and **Francis A. J. FitzGerald**, Niagara Falls, N. Y., assignors to Imbert Process Co., New York. Filed May 13, 1909. Issued March 1, 1910.

A revolving electric furnace having a carbon resistor as a central core. 15 claims.

- 1446 950,879. Electric furnace.—**John Thomson**, New York, N. Y., assignor to Imbert Process Company, New York. Filed Sept. 1, 1909. Issued March 1, 1910.

A resistor for an electric furnace comprising a plurality of interlocking resistance elements. 34 claims.

- 1447 950,880. Electric furnace.—**John Thomson**, New York, N. Y., assignor to Imbert Process Company, New York. Filed Sept. 1, 1909. Issued March 1, 1910.

A revoluble electric furnace having a resistor composed of interlocking members. 16 claims.

- 1448 950,881. Electric furnace.—**John Thomson**, New York, N. Y., assignor to Imbert Process Company, New York. Filed Sept. 1, 1909. Issued March 1, 1910.

An electric furnace having a self-supporting resister composed of a plurality of irregular blocks arranged in the form of a flat arch. 14 claims.

- 1449 950,882. Electric furnace.—**John Thomson**, New York, N. Y., assignor to Imbert Process Company, New York. Filed Sept. 1, 1909. Issued March 1, 1910.

A resister for an electric furnace comprising a plurality of blocks with their faces normally only partially in contact and so constructed and arranged that upon deformation under heat the area of contact between the blocks will increase.

- 1450 957,337. Electric furnace for smelting zinc.—**Hiram W. Hixon**, Philadelphia. Filed June 11, 1909. Issued May 10, 1910. 6 claims.

See also item 1338.

- 1451 957,058. Electric furnace for smelting zinc.—**Hiram W. Hixon**, Philadelphia. Filed Nov. 30, 1909. Issued May 3, 1910.

- 1452 964,268. Apparatus for smelting ore yielding a volatile metal.—**Woolsey McA. Johnson**, Hartford, Conn., assignor to The Continuous Zinc Furnace Company. Filed Nov. 9, 1906. Issued July 12, 1910.

Apparatus for smelting ores yielding a volatile metal, comprising in operative connection, an electric smelting furnace, a porous body of carbonaceous material, a condenser, and means for heating said body of carbonaceous material. 6 claims. See also item 1338.

- 1453 978,465. Electrometallurgical furnace.—**Francois Louvrier**, Mexico, Mexico. Filed Dec. 18, 1909. Issued Dec. 13, 1910.

A furnace comprising a plurality of reduction chambers electrically arranged in series, a preliminary crucible communicating with said reduction chambers and connecting them electrically, by way of the metal that it contains, means to prevent the prolonged contact of reduced metal with reduction slag and means for conducting an electric current through the reducing chambers and preliminary crucible. 8 claims.

- 1454 980,763. Electric furnace for the continuous extraction of zinc from its ores.—**Eugene Francois Cote** and **Paul Rambert Pierron**, Lyons, France. Filed Aug. 13, 1908. Issued Jan. 3, 1911. Six claims. Patented also in France, No. 385,018.

- 1455 989,169. Electrometallurgical furnace.—**Francois Louvrier**, Mexico, Mexico. Filed Dec. 18, 1909. Issued April 11, 1911.

A furnace comprising a furnace body, a condensing chamber built up within the furnace body in such manner as to divide the interior thereof into two separate and distinct reduction chambers, and provided with openings through the upper parts of its walls to allow inflow of volatilized metals from the reduction chambers; means for charging the reduction chambers, and means for reducing the charge.

- 1456 1,006,876. Metallurgy of zinc ores and compounds.—**Augustin L. J. Queneau**, Overbrook, Pa., assignor to Queneau Electric Zinc Furnace Corporation, Philadelphia. Filed Jan. 7, 1910. Issued October 24, 1911.

The method of reducing zinc ores and compounds which consists in establishing within a reducing chamber a fluid resistor, introducing into the chamber the zinc ore charge, its reducing constituent being not materially in excess of that required for the reduction, maintaining the temperature of the charge at the reducing point by passing an electric current through the resistor, and tumbling the contents of the chamber in the presence of a highly liquid slag. 30 claims.

—Described in Met. & Chem. Eng., vol. 9, p. 662. Dec., 1911.

- 1457 1,006,877. Metallurgy of zinc.—**Augustin L. J. Queneau**, Philadelphia, Pa., assignor to Queneau Electric Furnace Company, Philadelphia. Filed June 8, 1911. Issued Oct. 24, 1911.

An electric furnace for the metallurgy of zinc ores and compounds, comprising a reducing chamber, a fluid resistor therein and means for heating said fluid resistor electrically, the electric current being introduced into the fluid resistor and taking its exit therefrom through the intermediacy of a portion of the furnace lining consisting of a mixture of refractory material and carbonaceous material constituting an electrical conducting body of the first order. 10 claims. Patented also in England, No. 19,305 of 1911; in France, No. 443,750.

- 1458 1,030,349. Metallurgy of zinc.—**Charles V. Thierry**, Paris, France. Filed Oct. 6, 1911. Issued June 25, 1912.

Consists in maintaining in an electric furnace from which air is excluded from the reducing zone, a composite charge composed of commercial metallic oxides and carbon, the said elements being electrically heated and the nature of the oxide being such that when subjected to an adequate temperature in the presence of carbon, it will volatilize; the oxide and the carbon being charged in such relative proportions that the reaction will convert the entire charge to the forms of fumes, gases, vapors and a relatively small proportion of ash or sintered residue, said volatilized products continuously escaping from the reaction chamber as and when produced. 6 claims. Patented also in England, No. 19,973 of 1911.

—Described in Met. & Chem. Eng., vol. 10, p. 490-491. Aug., 1912.

- 1459 1,030,350. Metallurgy of zinc.—**Charles V. Thierry**, Paris, France. Filed Oct. 6, 1911. Issued June 25, 1912.

In the metallurgy of zinc, the placing and maintaining of a composite charge of commercially pure oxide of zinc and of carbon direc-

ly upon a separate carbon resistor of an electric furnace, from which air is excluded, the relative proportions of the charged materials being such that when a sufficient current is passed through the resistor to produce reaction in the superimposed oxide of zinc and the carbon they will be completely transmuted into fumes, gases, vapors and inert ash or sintered residue, the volatilized products automatically passing from the reducing zone, as and when produced, but the residue remaining upon, in or beneath the resistor until otherwise removed. 12 claims. Patented also in England, No. 20,913 of 1911.

—Described in Met. & Chem. Eng., vol. 10, p. 490-491. Aug., 1912.

- 1460** 1,030,351. Metallurgy of zinc.—**Charles V. Thierry**, Paris, France. Filed Nov. 2, 1911. Issued June 25, 1912.

A process for the extraction of zinc from blue-powder produced during zinc-smelting, which comprises treating the said powder with a substance which acts on the covering of the particles thereof to form a compound soluble in water or other liquid, and subsequently consolidating said particles. 9 claims. Patented also in England, No. 21,014 of 1911; in France, No. 439,143.

—Described in Met. & Chem. Eng., vol. 10, p. 491. Aug., 1912.

- 1460a** 1,051,512. Ore-reducing furnace.—**Peter Evert Peterson**, Butte, Mont. Filed May 10, 1912. Issued Jan. 28, 1913.

See also item 1332.

- 1461** 1,057,878. Production of zinc and the like.—**Antoine Bonaventure Pescatore**, London, England. Filed Nov. 20, 1911. Issued April 1, 1913.

A process for the production of zinc and the like in shaft or like blast furnaces which consists in providing a limited supply of air for the furnace, such that the combustion gases in the reduction zone are kept free of oxygen and carbonic acid gas and at the same time increasing the temperature in this zone by electric heating as set forth. 10 claims. Patented also in England, No. 29,839 of 1910; in France, No. 436,650.

- 1462** 1,059,342. Process for reducing zinc oxides.—**Charles F. Burgess**, Madison, Wis. Filed Oct. 8, 1909. Issued April 22, 1913.

The process of reducing zinc oxide which consists in electrically heating said oxide to a temperature sufficient to produce volatilization in one chamber, simultaneously heating a mass of carbon in the second chamber and conducting the vapors of the zinc oxide from said first chamber to said second chamber. 19 claims. See also item 1386.

- 1463** 1,064,992. Metallurgy of zinc.—**Augustin L. J. Queneau**, Philadelphia, Pa., assignor to Queneau Electric Zinc Furnace Company, Philadelphia. Filed April 2, 1909. Issued June 17, 1913.

An electric furnace, having a rotary main body chamber, provided with an interior peripheral lining having a series of longitud-

inal courses of solid peripheral conductors forming a part of said lining and separated from each other by longitudinal courses of solid peripheral non-conductors, said conductors having a break in their electric conductivity and being bridged successively at the bottom of the chamber and across said break by molten resisting material. See also item 1326.

- 1464 1,080,862. Electric zinc furnace with integral condenser—**John Thomson**, New York, N. Y. Filed Jan. 2, 1913. Issued Dec. 9, 1913. 12 claims.
- 1465 1,080,863. Electric zinc furnace with integral condenser.—**John Thomson**, New York, N. Y. Filed Jan. 2, 1913. Issued Dec. 9, 1913. 23 claims.
- 1466 1,080,864. Electric zinc furnace with integral compound condenser.—**John Thomson**, New York, N. Y. Filed Jan. 2, 1913. Issued Dec. 9, 1913. 14 claims.
- 1467 1,080,865. Electric furnace with integral condenser.—**John Thomson**, New York, N. Y. Filed Jan. 2, 1913. Issued Dec. 9, 1913. 17 claims.
- 1468 1,080,866. Electric zinc furnace with integral condenser.—**John Thomson**, New York, N. Y. Filed Jan. 2, 1913. Issued Dec. 9, 1913. 18 claims.
- 1469 1,080,912. Method of electrically smelting volatile metals.—**Woolsey McA. Johnson**, Hartford, Conn. Filed Jan. 17, 1911. Issued Dec. 9, 1913.

The method of smelting ores yielding a volatile metal, which consists in electrically heating a charge proportioned to yield a fusible slag, conducting the volatile reaction products into contact with carbon heated to its temperature of maximum reductivity, continuously replacing the carbon and condensing the metal. 17 claims.
- 1470 1,086,414. Electric zinc furnace with integral condenser.—**John Thomson**, New York, N. Y. Filed Jan. 2, 1913. Issued Feb. 10, 1914. 20 claims.
- 1471 1,086,415. Electric zinc furnace with integral condenser.—**John Thomson**, New York, N. Y. Filed Jan. 2, 1913. Issued Feb. 10, 1914. 15 claims.
- 1472 1,086,416. Electric zinc furnace with integral compound resistors and compound condensers.—**John Thomson**, New York, N. Y. Filed Jan. 2, 1913. Issued Feb. 10, 1914. 16 claims.
- 1473 1,086,417. Electric zinc furnace with integral condenser.—**John Thomson**, New York, N. Y. Filed April 14, 1913. Issued Feb. 10, 1914. 20 claims.

- 1474 1,086,418. Universal electric zinc furnace with integral condenser.—**John Thomson**, New York, N. Y. Filed May 8, 1913. Issued Feb. 10, 1914. 15 claims.
- 1475 1,088,496. Electrical heating device for metallurgical furnaces.—**Utley Wedge**, Ardmore, Pa. Filed June 19, 1912. Issued Feb. 24, 1914.
- 1476 1,090,427. Electric zinc furnace with integral condenser.—**John Thomson**, New York, N. Y. Filed Jan. 2, 1913. Issued March 17, 1914.
In an electric zinc furnace, a grate upon which a bed-of-carbon resistor is supported, the resistor being arranged to act upon a charge when the latter is placed in the furnace. 30 claims.
- 1477 1,090,428. Electric zinc furnace with integral condenser.—**John Thomson**, New York, N. Y. Filed April 14, 1913. Issued March 17, 1914.
An electric zinc furnace essentially comprising compound parallel porous resistors adapted to act upon charge material disposed along one of the vertical sides of each resistor, and fume condensing systems disposed along vertical sides of said resistors opposite to the zones of the reaction. 30 claims.
- 1478 1,092,764. Electric furnace for metallurgical purposes.—**Henry H. Buckman, Jr.**, Indianapolis. Filed June 30, 1913. Issued April 7, 1914.
See also item 1291.
- 1479 1,099,211. Process of and apparatus for producing zinc and other similar metals.—**Heinrich Specketer**, Griesheim-on-the-Main, Germany. Filed May 6, 1912. Issued June 9, 1914.
The process of producing zinc and other similar metals, which consists in charging a conductive mixture of zinciferous material and reducing agents into a furnace, directing an electric current through this mixture which acts as resistance, and turning over this mixture while it is maintained in an unsmelted condition so that its lowest layers are replaced from time to time without leaving the furnace by other portions of the mixture. 7 claims. See also items 1339 and 1404.
- 1480 1,110,359. Electric zinc furnace with integral condenser.—**Charles Victor Thierry**, Paris, France. Filed May 21, 1913. Issued Sept. 15, 1914.
An electric zinc furnace having a fume condensing system contained in the longitudinal side-walls and sole or bottom of the reaction chamber. Patented also in England, No. 7,953 of 1913; in France, No. 456,180. See also item 1334.
- 1481 1,121,874. Zinc furnace.—**Otto Ernst Ruhoff**, Madison, Wis. Filed March 26, 1914. Issued Dec. 22, 1914. 8 claims.

- 1482 1,122,663. Electric zinc furnace with integral condenser.—**Charles Victor Thierry and Michel Thierry**, Paris, France. Filed May 21, 1913. Issued Dec. 29, 1914.

An electric zinc furnace having a resistor whose side surfaces are partially retained by spaced plates, a sump directly beneath the resistor and by means of which the said resistor is sustained. 13 claims.

- 1483 1,122,664. Electric zinc furnace with integral condenser.—**Charles Victor Thierry and Michel Thierry**, Paris, France. Filed May 21, 1913. Issued Dec. 29, 1914.

- 1484 1,146,075. Process of treating zinc-bearing materials.—**Woolsey McA. Johnson**, Hartford, Conn., assignor to The Continuous Furnace Company, Hartford. Filed June 27, 1913. Issued July 13, 1915.

A cyclical process of treating a charge of zinc-bearing material low in sulphur and containing silica, which consists in electrically heating the said charge in presence of molten iron, producing thereby metallic zinc and a ferruginous silicate slag, condensing the evolved zinc vapors recovering iron from the said ferruginous silicate slag, and utilizing the reduced iron to further reduce quantities of zinc-bearing material. See also item 1393.

- 1485 1,150,271. Electric reduction of zinc ores.—**Woolsey McA. Johnson**, Hartford, Conn., assignor to The Continuous Zinc Furnace Company, Hartford. Filed Oct. 17, 1912. Issued Aug. 17, 1915.

In the electric reduction of complex zinc ores, including in their analysis sulphur, lead and calcium or barium, preliminary calcining said ores to the substantial elimination of sulphates with the exception of sulphate of lead and such sulphates of calcium and barium as are present, and then reducing the residual sulphates to sulphides. 5 claims. See also item 1382.

- 1486 1,153,786. Reduction of metallic oxides and the like.—**Frank William Highfield**, Caversham, England. Filed March 15, 1915. Issued Sept. 14, 1915.

In a furnace for the recovery of zinc from an oxidized condition thereof, the combination of a wall of material that is porous to carbon monoxide at the working temperature of the furnace and that divides the said zinc in its oxidized condition from the atmosphere of the furnace, electrically heated carbon adjacent to the said wall to heat it and to provide a furnace atmosphere of carbon monoxide, a grate beneath the carbon to support it, a chamber beneath the grate to receive the reduced metal and a cooling chamber in direct communication with the said receiving chamber. See also item 1387.

- 1487 1,160,244. Treating materials in electric furnaces.—**Edward Salomon Berglund**, Trollhattan, Sweden. Filed April 21 1915. Issued Nov. 16, 1915.

See also item 1397.

—Described in Jour. Soc. Chem. Ind., vol. 35, p. 259. Feb. 29, 1916.

- 1488 1,165,371. Duplex smelting process.—**Woolsey McA. Johnson** and **Edwin W. Hale**, Hartford, Conn., assignors to The Continuous Zinc Furnace Company, Hartford. Filed March 16, 1914. Issued Dec. 21, 1915.

A process for reducing high-grade zinc ores consisting in obtaining the zinc-bearing material in a state having a low sulphur content then forming a retort charge thereof by the addition of carbon, then heating said mixture in a retort externally heated to a temperature rising to about 1150° C., as a maximum, thereafter utilizing the residue from said retort together with additional carbon for preparing another mixture, and then obtaining the ultimate metallic values by electrically developing heat within the charge while enclosed in an air-excluding container.

—Described in Jour. Soc. Chem. Ind., vol. 35, p. 259. Feb. 29, 1916.

- 1489 1,167,176. Smelting of ores and apparatus therefor.—**Frank William Highfield**, Caversham, England. Filed Feb. 23, 1915. Issued Jan. 4, 1916.

The process for the reduction of complex sulphide ores which consists in roasting the ore to remove the sulphur therefrom, mixing the roasted ore with a reducing agent and heating the charge electrically in a reducing atmosphere to a temperature of 950° C. at which the zinc content is volatilized but the lead is not and the latter is thereby separated in a liquid condition from the former, separating the molten lead from the residual matte and heating said matte electrically to a temperature of 1300° C. for the formation of silicious slags and subjecting the matte of copper and iron sulphides while it is still liquid to the action of a direct current to promote separation of its iron and copper contents and decomposition of the copper and iron sulphides. Patented also in England, Nos. 4,937 and 2,728 in 1914; in France, No. 478,778.

- 1490 1,167,998. Process of obtaining metals, such as lead or zinc, in an electric furnace.—**Alois Helfenstein**, Vienna, Austria-Hungary. Filed Feb. 2, 1914. Issued Jan. 11, 1916.

A process for obtaining metal vapors, especially those of zinc and lead, from ores in an electric furnace, which consists of preheating the charge before the distillation process takes place, exhausting the gases and vapors developed in the preheating zone to free the metallic vapors from gases favoring oxides or formation of metallic dust and exhausting part of the carbon oxides and metal vapors generated in the distillation zone. Patented also in France, No. 468,445. See also item 1333.

- 1491 1,184,520. Electric furnace permitting the extraction in a state of purity of zinc from its ores.—**Eugene Francois Cote** and **Paul Rambert Pierron**, Lyons, France, assignors to Societe Anonymne pour l'Electrometallurgie du zinc. Filed July 24, 1914. Issued May 23, 1916.

An apparatus for extracting zinc from ores in a state of purity, comprising a furnace for melting the ores, and a refining furnace into which the zinc vapors from the melting furnace are delivered, said refining furnace being provided with means for condensing the

zinc vapors in the form of drops or powder and with means for re-distilling the zinc-drops or powder, whereby the metal will be refined successively with the production thereof while at a temperature next to the point of volatilization thereof. 15 claims. Patented also in England, No. 14,192 of 1914; in France, No. 474,321.

- 1492** 1,193,633. Electric fuming or distilling furnace and condenser therefor.—**John Thomson**, New York, N. Y., assignor to John Thomson Press Company, Jersey City. Filed Oct. 2, 1915. Issued Aug. 8, 1916. 19 claims.

See also item 1329.

- 1493** 1,197,137. Method of reducing metals.—**Robert J. McNitt**, Perth Amboy, N. Y., assignor to the Roessler & Hasslach Chemical Company, New York. Filed Jan. 2, 1913. Issued Sept. 5, 1916.

A method of reducing metallic compounds to their metals by electrolysis consisting in raising the boiling point of said metals by pressure on the molten electrolyte while maintaining the temperature of the electrolyte below its boiling point at atmosphere pressure. 12 claims.

- 1494** 1,207,127. Method of and apparatus for obtaining zinc.—**Edward S. Berglund**, Trollhattan, Sweden, assignor to Trollhattans Elektrothermiska Aktiebolag, Trollhattan, Sweden. Filed Sept. 15, 1914. Issued Dec. 5, 1916.

In extracting zinc in an electric furnace the method of reducing and purifying the metallic vapors developed in the furnace, consisting in passing said vapors after leaving the furnace and on their way to the condenser, over a layer of reducing material, without passing them through such material and heating them above the condensing temperature. 6 claims.

- 1495** 1,213,180. Recovery of zinc.—**Charles H. Fulton**, Cleveland, Ohio. Filed July 17, 1916. Issued Jan. 23, 1917.

The method of recovering zinc, which consists in (1) mixing the ground and calcined ore with a reducing agent and a binder of such a character and in such proportions as will form briquets formed from such mixture to maintain their form and volume during the process of distillation, (2) forming such ore mixture into compact briquets under pressure, (3) preheating such briquets to drive off the volatile contents of the binder and convert the latter into coke, (4) interposing said briquets as a continuous resistor between the electrodes of a closed electric furnace and passing a current of electricity through them to heat them to a distilling temperature, and (5) recovering the zinc from the zinc vapor evolved by the distillation of the briquets. Patented also in England, No. 106,050 of 1916. See also item 1359.

—Described in Jour. Soc. Chem. Ind., vol. 36, p. 343. March 31, 1917.

- 1496** 1,214,842. Electric zinc-distilling furnace and condenser for producing blue powder.—**John Thomson**, New York, assignor to John Thomson Press Co., Jersey City, N. J. Filed Jan. 28, 1916. Issued Feb. 6, 1917.

An electric furnace for distilling spelter having attached condensers, adapted to receive zinc fume from a chamber formed by a ported septum and an overlying roof, the rate of heat radiation from said roof being controllable, whereby the temperature of the hot fume from the ported septum is reduced, by contact with the roof, prior to entering the condenser.

- 1497** 1,219,193. Condenser in the metallurgy of zinc.—**John Thomson**, New York, N. Y., and **Francis A. J. FitzGerald**, Niagara Falls, N. Y., assignors to John Thomson Press Company, Jersey City, N. J. Filed June 21, 1916. Issued March 13, 1917.

In the metallurgy of zinc, a condenser, set at a decline from the source of fume-supply and in which liquid metal is produced but not retained, combined with a separate underlying receptacle disposed in such manner that it can be removed without disturbing the said condenser.

- 1498** 1,219,194. Electric zinc-distilling furnace.—**John Thomson**, New York, N. Y., and **Francis FitzGerald**, Niagara Falls, N. Y., assignors to John Thomson Press Company, Jersey City, N. J. Filed June 21, 1916. Issued March 13, 1917.

In an electric furnace, a suspended resistor embraced by an overhead horizontal and vertical side septums, so disposed within the main chamber as to provide fume passages between the furnace walls and along the top of the horizontal septum. 15 claims.

- 1498a** 1,220,111. Apparatus for refining metals by heating.—**Alois Helfenstein**, Vienna, Austria. Filed June 5, 1912. Issued March 20, 1917.

A long tubular furnace provided with charging openings and adapted to receive a thin metal bath, means for heating said bath by fuel, water cooled conductors extending with their ends into said bath within said furnace through the bottom thereof for short circuiting said bath, means for imparting to said furnace an intermittent rotary movement around its longitudinal axis, and means for supplying energy to said conductors. See also item 1274.

- 1499** 1,231,084. Apparatus for producing zinc and other similar metals.—**Heinrich Specketer**, Griesheim-on-the-Main, Germany. Filed Jan. 29, 1915. Issued June 26, 1917.

A rotary electric furnace provided with at least one partition disposed longitudinally in the furnace to divide the same into at least two reduction chambers. 9 claims. Patented also in Germany, No. 290,643.

- 1500** 1,236,395. Method and apparatus for extracting zinc.—**Edward Salomon Berglund**, Trollhattan, Sweden. Filed Feb. 15, 1916. Issued Aug. 14, 1917.

In the electro-thermic extraction of zinc, condensing the zinc vapors, precluding contact between air and zinc powder formed

and re-introducing the zinc powder into the furnace and thereby increasing the content of zinc in the furnace gases. 7 claims. See also item 1302.

- 1501** 1,242,337. Electrical distilling apparatus.—**Charles H. Fulton**, St. Louis, Mo., assignor to Metallurgical Laboratories, Inc., Chicago, Ills. Filed Dec. 7, 1916. Issued Oct. 9, 1917. 34 claims. Patented also in England, No. 111,835 of 1917.

—Described in Met. & Chem. Eng., vol. 18, p. 539-40. May 15, 1918.

- 1502** 1,242,339. Process for distilling metallic ores.—**Charles H. Fulton** and **Thomas M. Bains, Jr.**, St. Louis, Mo., assignors to Metallurgical Laboratories, Inc., Chicago, Ills. Filed Jan. 24, 1917. Issued Oct. 9, 1917.

A distilling process, characterized by forming metallic ore or metal-bearing material into briquets that will retain their substantially original form and volume when subjected to a distilling temperature, causing said briquets to travel through a distilling chamber, and subjecting said briquets to heat while they are in said chamber. 16 claims. Patented also in England, No. 112,924 of 1917.

—Described in Met. & Chem. Eng., vol. 18, p. 539-40. May 15, 1918.

- 1503** 1,242,340. Apparatus for distilling metallic ores and metal-bearing materials.—**Charles H. Fulton** and **Thomas M. Bains**, St. Louis, Mo., assignors to Metallurgical Laboratories, Inc., Chicago, Ills. Filed Jan. 24, 1917. Issued Oct. 9, 1917. 22 claims.

—Described in Met. & Chem. Eng., vol. 18, p. 539-40. May 15, 1918.

- 1504** 1,242,341. Electric furnace.—**Charles H. Fulton**, St. Louis, Mo., assignor to Metallurgical Laboratories, Inc., Chicago, Ills. Filed Feb. 23, 1917. Issued Oct. 9, 1917. 19 claims.

—Described in Met. & Chem. Eng., vol. 18, p. 539-40. May 15, 1918.

- 1505** 1,244,504. Continuous zinc smelter.—**Woolsey McA. Johnson**, Hartford, Conn. Filed Feb. 4, 1915. Issued Oct. 30, 1917.

A unitary smelting apparatus combining an electric furnace having heat-insulated walls; a preheating retort having heat-conducting thin walls and connected with said furnace whereby smelt-able material may be preheated in said retort and passed directly into said furnace without being exposed to air; and a fuel-burning furnace arranged to heat said retort; and a condenser adapted to receive all the gaseous products from said furnace.

—Described, with diag., in Met. & Chem. Eng., vol. 18, p. 654. June 15, 1918.

- 1506** 1,255,066. Process and apparatus for producing zinc and the like.—**Filip Tharaldsen**, Christiania, Norway. Filed Aug. 18, 1916. Issued Jan. 29, 1918.

The process for the continuous production of zinc and other volatile metals from their ores comprising introducing the charge in the shape of an approximately horizontal layer continuously into an electric radiation furnace, heating the surface of the layer by means of radiant electric heat to liberate the vapors of the volatile metal principally in said surface, conducting said vapors through a separate outlet into a condenser, and removing the residues of the charge. 6 claims.

—Described in *Met. & Chem. Eng.*, vol. 18, p. 654. June 15, 1918.

- 1506a** 1,264,628. Distilling process for recovering metals from ores and metal-bearing materials.—**Charles H. Fulton**, St. Louis, Missouri.

Forms the metal-bearing material into objects that will retain their approximately original form and volume when subjected to a distilling temperature, arranging one or more of said objects in a chamber, and subjecting said object or objects to heat of a sufficiently high temperature to distill the metal contained in same.

- 1507** 1,256,802. Process of extracting zinc from its ores.—**Edvin Andreas Johansson**, Trollhattan, Sweden, assignor to Societe Anonyme Metallurgique Precedes De Laval, Brussels, Belgium. Filed March 22, 1912. Issued Feb. 19, 1918.

The method of extracting zinc from its ores, which consists in introducing into an electric resistance furnace a charge containing sufficient carbon to combine with the oxygen of the ore to form carbon monoxide, passing an electric current through a portion of said ore to produce various degrees of heat in different parts of said ore, causing the carbon dioxide formed in the cooler parts of the charge to successively penetrate the hotter parts of the ore whereby the remaining unaltered carbon will reduce it to carbon monoxide.

—Described in *Met. & Chem. Eng.*, vol. 18, p. 654. June 15, 1918.

- 1507a** 1,265,973. Electric zinc-distilling furnace and condenser.—**John Thomson**, New York. Filed January 19, 1916. Issued May 14, 1918.

An electric furnace for distilling spelter having a condenser in which there is a plurality of staggered plates around the ends of a portion of which both fume and condensed metal may flow but around another portion of which only fume can flow. 7 claims.

- 1507b** 1,266,808. Method of converting zinc powder into liquid zinc.—**Sven Huldt**, Stockholm, Sweden, assignor to Norsk Elektrisk Metalindustri Aktieselskap, Sarpsborg, Norway. Filed April 3, 1917. Issued May 21, 1918.

The method of converting zinc powder into liquid zinc, consisting in heating the zinc powder to the melting temperature of the zinc and subjecting the powder to a rubbing operation. Patented also in England, No. 105,558 of 1917.

- 1507c 1,271,267. Electrothermic extraction of zinc.—**Edward Salomon Berglund**, Trollhättan, Sweden. Filed July 25, 1917. Issued July 2, 1918.

In electrothermic extraction of zinc, conducting zinc-containing vapors simultaneously from several smelting furnaces to one common condenser, and shutting off the communication from one of the said smelting furnaces without disturbing the working of the remaining furnaces. Patented also in England, No. 109,435 of 1917.

- 1507d 1,286,100. Electric furnace.—**B. Raeder**. Issued Nov. 26, 1918.

Especially adapted to the production of zinc.

Great Britain

- 1508 12,432 of 1890. Improvements in the manufacture or production of zinc from the oxidized ores of zinc.—**T. Parker** and **A. E. Robinson**, Wolverhampton.

The ore, if a sulphide or carbonate, is first roasted and then mixed with sufficient carbon in the form of charcoal, pitch, coke, or tar to effect its reduction and give proper electrical conduction.

- 1509 472 of 1900. Process and apparatus for obtaining zinc from its ores.—**C. Casoretti** and **F. Bertani**, Milan.

Furnace for combined retort and electric smelting. Patented also in Germany, No. 129,889.

—Described in *Zeits. f. angewandte Chem.*, vol. 15, pp. 437-438. May 6, 1902.

- 1510 23,756 of 1902. Process of extracting zinc and other volatile metals from their ores.—**Trollhattans Elektriska Kraftaktiebolag**, by **F. W. Howorth**, London.

A zinc distilling furnace in which the charge is fed down a sloping surface, exposed to the heat of an electric arc, the zinc being distilled off, and the remainder of the charge being melted and run off to the bottom. Patented also in France, no. 325,895.

- 1511 9,932 of 1903. Electric smelting furnace.—**Trollhattans Elektriska Kraftactiebolag**, Stockholm, Sweden.

Improvements in the inventor's furnace for smelting by means of the reflected heat of the electric arc, the charge slowly falling down an inclined surface.

- 1512 4,058 of 1904. Treating zinc blende and other substances containing zinc.—**W. and H. Simm**, Prescott, England. **R. Storey** and **J. S. Sellers**, Liverpool.

"The ore is heated in an electric furnace of the type described in 4,059 of 1904, into which air is subsequently admitted. The zinc oxide produced is condensed, and the sulphur dioxide or other gases utilized."—**J. S. C. I.**

- 1513 4,059 of 1904. Electric furnace.—**W. and H. Simm**, Prescott, England. **R. Storey** and **J. S. Sellers**, Liverpool.

"An electric resistance furnace with three or more cross-bars of carbon, connected alternately in parallel. The spaces between the bars are filled with a mixture of ground silica and carbon which serves as the resistance."—**J. S. C. I.**

- 1514 16,205 of 1904. Electric furnaces and extraction of zinc by means of same.—**A. Edelmann** and **N. Wallin**, Charlottenburg.
—Described in *Jour. Soc. Chem. Ind.*, vol. 23, p. 1035. Nov. 15, 1904.
- 1515 15,818 of 1906. Electric zinc furnace.—**K. Kaiser**, Berlin.
“In electric furnaces such as are intended for reducing zinc from zinciferous pyrites, using a blast of reducing gas instead of adding carbon to the charge.”—**E. & M. J.**
- 1516 18,712 of 1906. Electric furnace.—**F. T. Snyder**, Chicago.
“An electric furnace for smelting zinc ores that are not suitable for distilling owing to high lime contents.”—**E. & M. J.**
- 1517 24,096 of 1906. Process for the direct production of metallic zinc from zinc sulphide, and the subsequent utilization of the sulphur and regaining of the flux, desulphurating the zinc sulphide.—**Rhenisch-Nassauische Bergwerks und Huetten**—**A. G.**, Stolberg, **W. Borchers** and **A. Graumann**, Aix-la-Chapelle.
“Pulverized and unroasted zinc sulphide is mixed with finely divided metallic iron. The mixture is continuously fed into an electric furnace, preferably of the resistance type in which the charge forms the resistance, where at a temperature between 1000° and 1500° C., it is decomposed into metallic zinc, the vapor of which is condensed in any usual way, and ferrous sulphide, which is tapped off at intervals in the molten state...”—**J. S. C. I.**
—Described in *Jour. Soc. Chem. Ind.*, vol. 26, pp. 98-99. Feb. 15, 1907.
- 1518 22,283 of 1907. Electric furnace for the continuous extraction of zinc from its ores.—**Eugene F. Cote** and **Paul R. Pierron**, Lyons, France.
- 1519 18,653 of 1908. Electric furnace for the continuous distillation of zinc from its ores.—**Eugene F. Cote** and **Paul R. Pierron**, Lyons, France.
- 1520 25,979 of 1909. Method and furnace for the reduction of zinc.—**A. R. Lindblad** and **O. Stalhane**, Ludvika, Sweden.
Nov. 10, 1909.
- 1521 16,602 of 1915. Rotary electric furnace for the production of zinc and other metals.—**F. Cochlovius**, Buchschlag, Hessen, Germany.
—Described in *Jour. Soc. Chem. Ind.*, vol. 36, p. 343. March 31, 1917.
- 1522 10,613 of 1916. Refining zinc by volatilization in a continuous electric radiating furnace.—**S. Huldt**, Sweden.
—Described in *Min. Mag.*, vol. 16, p. 224. April, 1917.

1522a 106,050 of 1916. Distillation of zinc in the electric furnace.

—D. B. Jones.

"In the distillation of zinc in a closed furnace for obtaining zinc or zinc oxide, the current is passed through a series of resistive zinc ore briquettes of such character as to be unchanged in form by the distillation.

—Described in Chem. Abst., vol. 11, p. 2434. Sept. 10, 1917.

1523 4,954 of 1917. Reduction of zinc.—**Norsk Elektresk Metalindustri**, Sarpsborg, Norway.

Converting zinc powder into liquid zinc in a rotating electric furnace, the rotating action serving to remove the external oxide coating of the zinc particles.

1524 109,435 of 1917. Method of and arrangements for extracting zinc by the electro-thermal process.—**E. Berglund**, Trollhattan, Sweden.

France

1525 330,665. Electrochemical treatment of the minerals of zinc or other volatile metals, for the extraction of the metals which they contain.—**A. Salgues**. March 28, 1903.

Relates to an electric furnace rendered tight by the cooling of its external parts; the vapors are thus condensed and leakages stopped.

—Described in Jour. Soc. Chem. Ind., vol. 22, p. 1094. Oct. 15, 1903.

1526 343,114. Direct extraction of zinc from its ores.—**A. Rodriguez**, Bruna. April 20, 1904.

"Zinc ores are mixed with carbon and the mixture is heated under pressure in an electric furnace. It is stated that the zinc may be thus obtained in the melted state instead of as vapor."—**J. S. C. I.**

1527 382,872. Electric zinc furnace.—**G. H. Gin**. Oct. 14, 1907.

—Described, with diag., in Jour. Soc. Chem. Ind., vol. 27, p. 289. March 31, 1908.

See also item 1364.

1528 397,631. Process of treating blende for the manufacture of zinc sulphide.—**Eugene F. Cote** and **P. R. Pierron**. Feb. 28, 1908.

"Zinc blende is melted with iron in an electric furnace, and the zinc vapor produced is either treated at once with H_2S to convert it into sulphide, or it is first transformed into oxide."

—Described in Jour. Soc. Chem. Ind., vol. 28, p. 708. July 15, 1909.

1529 420,922. Electric furnace for the treatment of zinc ores or secondary metallurgical products.—**Societa di Monteponi**. Sept. 30, 1910.

- 1530 441,697. Method of extracting zinc from its ores.—**Soc. Anon. Metallurg. Proc. de Laval**. March 23, 1912.

The charge, containing excess of carbon, is fed from the sides into an electric resistance furnace, the electrodes, and the outlet for the gases formed being in the middle.

- 1531 480,633. Extraction of zinc.—**E. S. Berglund**. Jan. 7, 1916.

"The bulk of the zinc vapor is condensed as liquid metal and the remainder as zinc dust which is subsequently volatilized out of contact with air and re-condensed in the same system."

—Described in Jour. Soc. Chem. Ind., vol. 36, p. 145. Feb. 15, 1917.

Germany

- 1532 128,535. Smelting silicious zinc ores in the electric furnace.—**Alfred Dorsemagen**, Aix-la-Chapelle. Dec., 1900.

—Described in Zeits. f. angewandte Chem., vol. 15, p. 185. Feb. 25, 1902.

- 1533 132,205. Recovery of zinc, lead, copper, nickel or cobalt from sulphide ores or other materials.—**Friederich Darmstaedter**, Darmstadt, Germany. Sept. 19, 1899.

—Described in Zeits. f. angewandte Chem., vol. 15, pp. 632-33. June 24, 1902.

- 1534 148,439. Process for the continuous distillation of zinc in the electric furnace.—**Gustave de Laval**, Stockholm, Sweden, and **Trollhattans Elektriska Aktiebolag**. April 30, 1901.

See also next patent; also item 1400.

—Described in Zeits. f. angewandte Chem., vol. 17, p. 428. April 1, 1904.

- 1535 157,603. Continuous distillation of zinc in the electric furnace.—**Gustave de Laval**. April 30, 1901.

Modification of preceding patent.

- 1536 158,545. Recovery of zinc in an electric furnace, using a hollow electrode surrounded by the charge.—**Edelmann** and **Wallin**, Charlottenburg, Germany. July 24, 1903.

—Described, with diag., in Zeits. f. angewandte Chem., vol. 18, pp. 668-69. April 28, 1905.

- 1537 189,313. Process for the recovery of iron and zinc from zinciferous iron ores and smelter products, such as roasted pyrites, by treatment in the electric furnace.—**K. Kaiser**, Berlin. July 20, 1905.

—Described in Zeits. f. angewandte Chem., vol. 21, p. 166. Jan. 24, 1908.

- 1538 200,668. Continuous recovery of zinc in fluid state in an electric furnace with heated condensation chamber.—**Eugene F. Cote** and **Paul R. Pierron**, Lyons, France. March 1, 1907.
See also item 1369.
—Described, with diag., in *Zeits. f. angewandte Chem.*, vol. 21, p. 1992. Sept. 18, 1908.
- 1539 206,148. Electric furnace for the continuous recovery of zinc from ores.—**Eugene F. Cote** and **Paul R. Pierron**, Lyons, France.
See also item 1354.
—Described, with diag., *Zeits. f. angewandte Chem.*, vol. 22, p. 546. March 19, 1909.
- 1540 203,085. Recovery of zinc from ores, using an electric induction furnace.—**Gustave Gin**, Paris. Dec. 5, 1907.
—Described in *Zeits. f. angewandte Chem.*, vol. 22, pp. 844-45. April 30, 1909.
- 1541 208,451. Production of zinc oxide by the smelting of zinc ores and other zincy materials in the electric furnace.—**William** and **Henry Simm**, Prescott, England. Oct. 3, 1907.
—Described in *Zeits. f. angewandte Chem.*, vol. 22, p. 885. May 7, 1909.
- 1542 210,030. Process and apparatus for recovery of zinc by precipitation process in the electric furnace.—**E. F. Cote** and **P. R. Pierron**. Sept. 16, 1908.
See also item 1363.
—Described in *Zeits. f. angewandte Chem.*, vol. 22, p. 1465. July 16, 1909.
- 1543 232,928. Process and apparatus for the reduction of zinc ores in the electric furnace, using a fluid resistant.—**A. L. J. Queneau**, Philadelphia, Pa. May 15, 1909.
—Described in *Zeits. f. angewandte Chem.*, vol. 24, p. 814. April 28, 1911.
- 1544 235,914. Production of zinc in the electric furnace.—**Alex. R. Lindblad** and **Otto Stalhane**, Ludvika, Sweden.
—Described, with diag., in *Zeits. f. angewandte Chem.*, vol. 24, p. 1493-94. Aug. 4, 1911.
- 1545 245,365. Recovery of metallic zinc from its ores by treating the dessicated or roasted ores with hydrofluoric acid or fluosilicic acid to form zinc fluoride, mixed with zinc oxide and smelted in an electric furnace.—**Gino Gallo**, Rome, Italy. Jan. 26, 1911.

- 1546 254,029. Recovery of zinc and similar metals in the electric furnace, using the charge as heat resistant.—**H. Specketer**, Griesheim-am-Main, Germany. June 11, 1911. See also German Patent 282,795.
—Described in *Zeits. f. angewandte Chem.*, vol. 26, pt. II, p. 56. Jan. 28, 1913.
- 1547 261,188. Process for the production of zinc, using a fluid slag bath.—**F. Tharaldsen**, Trondjem, Norway. March 12, 1912.
See also items 1337, 1405 and 1552.
—Described, with diag., in *Zeits. f. angewandte Chem.*, vol. 26, pt. II, p. 440. July 22, 1913.
- 1548 272,537. Process for the recovery of zinc or other easily volatilized metals.—**Roman von Zelewski**, Engis, Belgium. Dec. 8, 1912.
—Described in *Zeits. f. angewandte Chem.*, vol. 27, pt. II, p. 301. May 8, 1914.
- 1549 275,904. Process for separation of copper, lead and zinc from their sulphide and oxide ores and by-products, by a combined roasting, smelting, volatilizing and leaching process.—**Wilhelm Borchers**, Aix-la-Chapelle, and **Wilhelm Menzel**, Hamburg, Germany. July 29, 1913.
—Described in *Zeits. f. angewandte Chem.*, vol. 27, pt. II, p. 523. Sept. 4, 1914.
- 1550 282,141. Process for the electrothermic recovery of volatile metals, especially zinc.—**Max Breslauer**, Berlin. Jan. 30, 1913.
—Described in *Zeits. f. angewandte Chem.*, vol. 28, pt. II, p. 143. March 19, 1915.
- 1551 282,795. Process for the production of zinc and similar metals.—**H. Specketer**, Griesheim, Germany. Feb. 6, 1914.
Modification of 254,029. The zinc is only partially recovered —about 70%—in the first furnace, and the process is completed in a smaller one.
—Described in *Zeits. f. angewandte Chem.*, vol. 28, pt. II, p. 202. April 16, 1915.
- 1552 286,228 and 286,229. Process and apparatus for the production of zinc, using a fluid slag bath.—**F. Tharaldsen**, Trondjem, Norway. March 28 and 31, 1914.
Modifications of 261,188, above.
—Described in *Jour. Soc. Chem. Ind.*, vol. 35, p. 185. Feb. 15, 1916.
—Described in *Zeits. f. angewandte Chem.*, vol. 28, pt. II, p. 489. Sept. 24, 1915.

- 1553 286,557. Process and apparatus for cleaning the surface of a zinc bath in an electric furnace for refining zinc by distillation.—**A/S Metalforedling**, Tronjhem, Norway. April 9, 1914.
—Described in Jour. Soc. Chem. Ind., vol. 35, p. 185, Feb. 15, 1916.
- 1554 288,616. Electric furnace for the recovery of zinc and other volatile metals.—**O. Schneemilch**. Dec. 12, 1913.
See also item 1353.
—Described in Jour. Soc. Chem. Ind., vol. 35, p. 426. April 15, 1916.
- 1555 288,684. Electric metallurgical furnace for the extraction of zinc and the like.—**Coswiger Braunkohlwerke G. m. b. H.**, Coswig, Anhalt, Germany. Jan. 19, 1913.
See also item 1352.
—Described in Jour. Soc. Chem. Ind., vol. 35, pp. 426-27. April 15, 1916.
- 1556 289,493. Method of condensing metallic vapors, especially zinc, in the electric furnace.—**A/S Metalforedling**, Tronjhem, Norway. March 27, 1914.
"The gases and metallic vapors pass from the furnace down inclined tubes sufficiently long to insure the condensation of the metal to the liquid state. Uptakes containing coke are provided for the escape of the non-condensable gases."
—Described in Jour. Soc. Chem. Ind., vol. 35, p. 427. April 15, 1916.
- 1557 290,499. Furnace for the electrothermic extraction of zinc.—**A/S Metalforedling**, Tronjhem, Norway. April 5, 1914.
—Described in Jour. Soc. Chem. Ind., vol. 35, p. 606. May 31, 1916.
- 1558 290,690. Method of condensing metallic vapors, especially those of zinc, in the electric furnace.—**A/S Metalforedling**, Trondhjem, Norway. May 20, 1914.
The uptakes are filled with pieces of coke, so that they act as gas-cushions and equalize fluctuations of pressure in the furnace.
—Described in Jour. Soc. Chem. Ind., vol. 35, p. 606. May 31, 1916.
- 1559 291,492. Apparatus for the condensation of zinc vapor in the electric furnace.—**A/S Metalforedling**, Trondhjem, Norway. March 31, 1914.
—Described in Jour. Soc. Chem. Ind., vol. 35, p. 695. June 30, 1916.
—Described in Chem. Abst., vol. 11, p. 921. April 20, 1917.

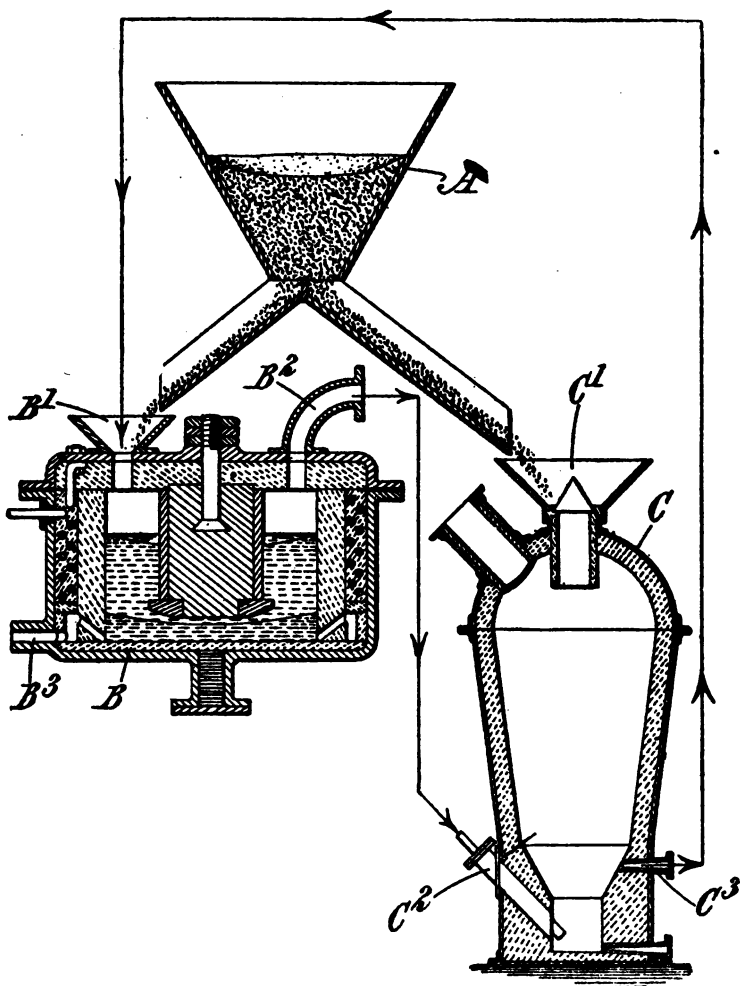
- 1560 292,471. Production of zinc.—**F. Tharaldsen**, Trondhjem, Norway. April 23, 1915.

The gases produced on treating the slag (see 286,228) are led into a condensing chamber connected with the furnace instead of into a separate chamber.

—Described in Jour. Soc. Chem. Ind., vol. 35, p. 850. Aug. 15, 1916.

- 1560a 307,293. Process for the recovery of zinc from zinc dust.—**Norsk Elektrisk Metalindustri Aktieselskap**, Sundloekken, Norway. Aug. 13, 1918.

—Abstract, in German. diagr. Zeits. f. angewandte Chem., vol. 31, p. 289. Sept. 27, 1918.



ASHCROFT'S APPARATUS FOR ELECTROLYSIS OF FUSED ZINC
SULPHIDE
(See item 1616)

ELECTROLYSIS OF FUSED MATERIALS

See also items 1633, 1633a.

- 1561 The Ashcroft-Swinburne process. *Eng. & Min. Jour.*, vol. 76, p. 162. Aug. 1, 1903.
- 1562 Beitrag zur Elektrolyse der Zinksalze.—**G. Nahnsen**. *Berg. u. Huetten. Zeitg.*, vol. 50, pp. 393-97. Oct. 23, 1891.
- 1563 Chlorine smelting, with electrolysis.—**James Swinburne**. *Electrician*, vol. 51, pp. 495-96, 583-84. July 10, 24, 1903.
 Paper before the Faraday Society describing the author's process for electrolyzing zinc or lead chlorides. Cost data.
 —Abstract. *Jour. Soc. Chem. Ind.*, vol. 22, p. 953. Aug. 31, 1903.
 —Abstract. *Electrochem. Ind.*, vol. 1, pp. 412-13. Aug., 1903.
- 1564 Chloro-electrolytic smelting. *diagr. Electrochem. & Met. Ind.*, vol. 3, pp. 63-66. Feb., 1905.
- 1565 Demonstration zur Elektrolyse geschmolzener Salze.—**Richard Lorenz**. *diagr. Zeits. f. Elektrochem.*, vol. 7, pp. 277-87. Nov. 15, 1900.
 Electrolysis of fused salts. Paper at Seventh General Conference of the German Electrochemical Society. See also item 1574.
- 1566 Einige Worte ueber die Chlorzinkelektrolyse nach Dr. Hoepfner.—**E. Guenther**. *Metall. u. Erz.*, vol. 10, pp. 206-7. Jan. 8, 1913.
 —Abstract. *Zeits. f. angewandte Chem.*, vol. 26, pt. II, p. 250. April 22, 1913.
- 1567 The electric smelting of complex sulphides.—**A. A. Beadle**. *diagr. Eng. & Min. Jour.*, vol. 77, pp. 479-80. March 24, 1904.
 A discussion of the principles underlying leaching and electrolysis of fused zinc salts.
- 1568 Electrolysis of fused materials containing zinc.—**Chun Hao Wang**. *Columbia University, N. Y.*, 1914. 45 pp.
 Thesis for Ph.D. degree. Review of existing literature, and report of experiments on electrolysis of aqueous zinc salt solutions, precipitation of zinc from fused baths, electrothermal treatment of zinc ores, determination of freezing points of several salts and their mixtures, etc.
 —Abstract. *Met. & Chem. Eng.*, vol. 12, p. 523. Aug., 1914
 —Abstract. *Chem. Abst.*, vol. 8, p. 3270. Oct. 10, 1914.

- 1569 Electrolysis of fused salts.—**A. Helfenstein.** Jour. Soc. Chem. Ind., vol. 19, p. 670. July 31, 1900.
—Abstract. Zeits. f. anorgan. Chem., vol. 23, pp. 255-316. 1900.
- 1570 The electrolysis of fused zinc chloride in cells heated externally.—**Julius L. F. Vogel.** illus., diagr. Faraday Soc., Trans., vol. 2, pp. 56-71. May, 1906.
—Abstract. Electrochem. & Met. Ind., vol. 4, p. 208. June, 1906.
—Abstract. Electrician, vol. 57, p. 305. June 8, 1906.
—Abstract. Jour. Soc. Chem. Ind., vol. 25, p. 595. June 30, 1906.
—Abstract. Sci. Abst. A., vol. 10, pp. 118-19. Feb., 1907.
- 1571 An electrolytic method for the reduction of blue powder.—**Warren F. Blecker.** Amer. Electrochem. Soc., Trans., vol. 21, pp. 359-69. 1912.
—Abstract. The reduction of blue powder in zinc smelting. Min. Wld., vol. 36, pp. 951-52. May 4, 1912.
—Abstract. Met. & Chem. Eng., vol. 10, p. 300. May, 1912.
- 1572 Electrolytic preparation of zinc and lead.—**Richard Lorenz.** Zeits. f. anorgan. Chem., vol. 10, pp. 78-116. 1895. (In German.)
—Abstract. Jour. Chem. Soc., vol. 70, pt II, pp. 22-24. 1896.
- 1573 Die Elektrolyse geschmolzener Salze.—**Richard Lorenz.** Halle, W. Knapp, 1905-6. 3 pts., 8°. (Monographien ueber angewandte elektrochemie, Bde. 20-22.)
Most of the papers comprising these three volumes were originally published in the Zeitschrift fuer anorganische Chemie. The collection has been referred to as a classic in the field of applied electrochemistry.
- 1574 Die Elektrolyse geschmolzener Salze.—**Richard Lorenz.** graphs. Zeits. f. Elektrokrochem., vol. 7, pp. 753-61. July 4, 1901.
See also item 1565.
- 1575 Die elektrolytische Zersetzungsspannung von geschmolzenem Zinkchlorid.—**Richard Lorenz.** Zeits. f. anorgan. Chem., vol. 12, pp. 272-76. 1896.
Electrolytic decomposition voltage of fused zinc chloride.
—Abstract. Zeits. f. Elektrochem., vol. 3, pp. 135-36. Sept. 20, 1896.
- 1576 Factory scale experiments with fused electrolytes.—**E. A. Ashcroft.** diagr. Electrochem. & Met. Ind., vol. 4, pp. 143-44, 178-80, 357-58. April, May, Sept., 1906.

"Uses cells provided with means for magnetically rotating the fused bath during electrolysis. For the recovery of zinc from zinc sulphide, the ore is suspended in an electrolyte of fused zinc chloride, and by working at 450° C., the sulphide is resolved into its elements."—J. S. C. I.

—Abstract. Jour. Soc. Chem. Ind., vol. 25, pp. 594-95, 1053. June 30, Nov. 15, 1906.

- 1577 Gewinnung von Zink mittels Elektrolyse aus Mischungen von Zinksulfid und geschmolzenem Zinkchlorid. Metallurgie, vol. 9, p. 493. Aug. 8, 1912.

Ashcroft's German Patent 245,683, for electrolysis of mixtures of zinc sulphide and fused zinc chloride.

- 1578 The mechanism of electrolytic transfer.—J. W. Richards. Amer. Electrochem. Soc., Trans, vol. 19, pp. 119-25. 1911.

Special reference to the electrolysis of fused salts.

—Abstract. Jour. Inst. Metals, vol. 6, pp. 327-28. 1911.

- 1579 Method of reducing metals. diagr. Min. & Sci. Press, vol. 113, p. 894. Dec. 16, 1916.

McNitt's patent, 1,197,137.

- 1580 A new method for the electrolytic winning and refining of metals.—Edwin M. Chance. Amer. Electrochem. Soc., vol. 17, pp. 235-38. 1910.

Electrolysis of a fused electrolyte in juxtaposition to a fused anode.

- 1581 Preparation and electrolysis of pure fused zinc chloride.—Siegfried Gruenauer. Zeits. f. anorgan. Chem., vol. 39, pp. 389-476. 1904. (In German.)

—Abstract. Sci. Abst. A, vol. 7, p. 841. Oct., 1904.

—Abstract. Jour. Chem. Soc., vol. 86, pt. II, p. 562. 1904.

—Abstract. Jour. Phys. Chem., vol. 9, p. 176. Feb., 1905.

- 1582 Refining of zinc from impure zinc dross in an electric furnace.—Charles A. Weeks. Met. & Chem. Eng., vol. 9, pp. 364-65. July, 1911.

Part of a longer article on Melting non-ferrous metals in an electric furnace.

—Abstract. Sci. Abst. B, vol. 14, p. 432. Oct., 1911.

—Abstract. Chem. Abst., vol. 5, p. 3199. Oct. 10, 1911.

- 1583 Sulphide ore treatment (Phoenix process).—Edgar A. Ashcroft. diagr. Inst. Min. & Met., Trans., vol. 9, pp. 378-418. 1901.

Discussion of Ashcroft-Swinburne process from the technical and commercial points of view.

—Abstract. diagr. Electrician, vol. 47, pp. 451-53. July 12, 1901.

—Abstract. diagr. Sci. Abst., vol. 4, pp. 973-75. Nov., 1901.

- 1584** Treatment of complex ores. diagr. *Met. & Chem. Eng.*, vol. 10, pp. 117-19. Feb., 1912.
 Discussion of four U. S. Patents (1,011,897-900) issued to E. A. Ashcroft for chlorination treatment and electrolysis of mixed lead-zinc ores or concentrates.
- 1585** Ueber das Leitvermoegeen von geschmolzenem Chlorzink.—**Hermann S. Schultze.** diagr. *Zeits. f. anorgan. Chem.*, vol. 20, pp. 333-39. 1899.
 Conductivity of fused zinc chloride.
 —Abstract. *Zeits. f. Elektrochem.*, vol. 6, pp. 125-26. Aug. 17, 1899.
- 1586** Ueber die Elektrolyse von geschmolzenem Chlorzink.—**Hermann S. Schultze.** diagr. *Zeits. f. anorgan. Chem.*, vol. 20, pp. 323-32. 1899.
 —Abstract. Electrolysis of fused zinc chloride. *Jour. Chem. Soc.*, vol. 76, pt. II, p. 657. 1899.
- 1587** The vapor pressures of some concentrated zinc-chloride solutions.—**Alan W. C. Menzies** and **Henrik Boving.** 8th Int. Cong. Appl. Chem., vol. 22, pp. 219-20. 1912.
- 1588** Verfahren und Vorrichtung zur Gewinnung von Zink und Blei. *Zeits. f. Elektrochem.*, vol. 2, p. 220. Aug. 20, 1895.
 Lorenz's German Patent 82,125. Zinciferous lead ores or lead-bearing zinc ores are converted into chlorides, and the fused salts subjected to fractional electrolysis at temperatures between 450° and 700°.
- 1589** Versuche ueber Gewinnung von Zink im fluessigen Zustande direkt aus Blende.—**Felix Thomas.** diagr. *Metallurgie*, vol. 7, pp. 706-10. Nov. 22, 1910.
 Researches in the recovery of liquid zinc electrolytically direct from blende. "Blende dissolves in a eutectic mixture of sodium, potassium and manganese silicates to the extent of only .5% at 900°, and a very small yield of zinc is obtained electrolytically. Yields up to 67% are obtained in a closed furnace under pressure, but a large part is in the form of zinc dust. Blende dissolves readily in a mixture of sodium and iron sulphides, which melts at 661°, but the yield of zinc on electrolysis is again small."
 —Abstract. Production of zinc direct from Blende. *Min. Mag.*, vol. 4, pp. 61-62. Jan., 1911.
 —Abstract. *Jour. Soc. Chem. Ind.*, vol. 29, p. 1457. Dec. 31, 1910.
 —Abstract. *Met. & Chem. Eng.*, vol. 9, p. 155. March, 1911.
 —Abstract. *Chem. Abst.*, vol. 5, p. 854. March 10, 1911.
 —Abstract. *Jour. Inst. Metals*, vol. 5, p. 298 1911.
 —Abstract. *Zeits. f. angewandte Chem.*, vol. 24, pp. 610-11 March 31, 1911.

- 1590 Versuche zur Begründung eines gemeinsamen Zink- und Bleigewinnungsverfahrens.—**Richard Lorenz.** Zeits. f. Elektrochem., vol. 2, pp. 318-37. Nov. 5, 1895.

Experiments in the fractional electrolysis of zinc and lead from fused chlorides.

—Abstract. Method of extracting zinc and lead from mixed ores. Jour. Soc. Chem. Ind., vol. 15, pp. 279-80. April 30, 1896.

- 1591 Weiterer Beitrage zur Kenntnis der Natur des Zinkschwammes.—**F. Foerster** and **O. Guenther.** Zeits. f. Elektrochem., vol. 6, pp. 301-3. Nov. 30, 1899.

The nature of zinc sponge. Contrary to the views expressed in their former paper (item 1595), the formation of spongy zinc can not be attributed to the presence of zinc oxide.

—Abstract. Jour. Soc. Chem. Ind., vol. 19, p. 155. Feb. 28, 1900.

- 1592 Zink aus Galmei. Zeits. f. Elektrochem., vol. 2, p. 198. Aug. 5, 1895.

Zinc from calamine. Hoepfner's English Patent 11,724 of 1894. Calcium chloride is added to form zinc chloride, which is subjected to electrolysis.

- 1593 Die Zugutemachung bisher schwer oder nicht verhuettbarer Zinkerze, zinkhaltiger Zwischen- und Abfallprodukte.—**W. Borchers.** Zeits. f. angewandte Chem., vol. 15, pp. 637-42. July 1, 1902.

Treatment of zinc ores and zinciferous waste products hitherto fusible with difficulty or not at all. Chlorination, lixiviation and electrolysis.

—Abstract. Jour. Soc. Chem. Ind., vol. 21, pp. 975-76. July 31, 1902.

—Abstract. Zeits. f. Elektrochem., vol. 8, pp. 707-9. Sept. 11, 1902.

- 1594 Zugutemachung bisher schwer oder nicht verhuettbarer Zinkerze, zinkhaltiger Zwischen- und Abfallprodukte.—**H. Danneel.** diagr. Zeits. f. Elektrochem., vol. 8, pp. 741-43. Sept. 25, 1902.

Discusses Borscher and Dorsewagen's method of chlorination and electrolysis; Borscher and von Kuegelgen's process of recovering zinc from galvanizers' wastes; Dorsewagen's process for smelting a mixture of calcined siliceous zinc ore and coal in an electric furnace, volatilizing the zinc; and other processes exhibited at the Duesseldorf Exposition of 1902.

—Abstract. Some new electrolytic zinc processes. diagr. Eng. & Min. Jour., vol. 74, p. 544. Oct. 25, 1902.

—Abstract. Reducing zinc from its ores. Electrochem. Ind., vol. 1, p. 105. Nov., 1902.

- 1595 Zur Kenntnis der Elektrolyse von Zinkchloridloesungen, und der Natur des Zinkschwamms.—**F. Foerster** and **O. Guenther**. *diagr. Zeits. f. Elektrochem.*, vol. 5, pp. 16-23. July 7, 1898.

Nature of zinc sponge and methods of preventing its formation; but see item 1591, above.

- Abstract. *Jour. Soc. Chem. Ind.*, vol. 17, pp. 771-72. Aug. 31, 1898.

Dry Chlorination The Malm and similar processes

- 1596 The design of a dry chlorination plant.—**Jean McCallum** and **E. J. Bruderlin**. *West. Chem. & Met.*, vol. 6, pp. 206-31. May, 1910.

Includes information on electrolysis of zinc chloride, electrolytic cells, roasting zinc concentrates, costs.

- 1597 The dry chlorination of complex ores.—**S. A. Ionides**. *diagr. Min. & Sci. Press*, vol. 112, pp. 781-88. May 27, 1916.

Process for extracting all the metals in an ore, their purification and reduction to metallic form; primarily for complex zinc sulphide ores. Work at the Bunker Hill and Sullivan Plant, Kellogg, Idaho.

- 1598 Dry chlorination of mixed sulphide ores. *diagr. Met. & Chem. Eng.*, vol. 11, p. 159. March, 1913.

Malm's Patent 1,049,746.

- 1599 The dry chlorination of sulphide ores.—**Harry J. Wolf**. *West. Chem. & Met.*, vol. 6, pp. 176-91. May, 1910.

Brief review of early processes and description of current practice. The Malm Process and the Western Metals Co.

- 1600 Importance of the Malm process in the metallurgy of complex ores.—**A. G. Brownlee**. *Amer. Min. Cong., Rept.*, 14, pp. 168-79. 1911.

- 1601 The Malm dry chlorination process.—**R. L. Herrick**. *illus. Mines & Minerals*, vol. 30, pp. 370-74. Jan., 1910.

—Abstract. Treatment of complex ores. *Jour. Inst. Metals*, vol. 3, p. 253. 1910.

—Abstract. *Mex. Min. Jour.*, vol. 10, No. 5, pp. 20-23. May, 1910.

- 1602 Malm dry chlorine process. *Min. Mag.*, vol. 1, p. 290. Dec., 1909.

Adverse editorial comment.

—Comment.—**E. A. Ashcroft**. Vol. 2, p. 41. Jan., 1910.

"The Electrolysis of pure anhydrous zinc chloride into chlorine and zinc is not a difficult or expensive operation."

—Editorial note. Vol. 2, pp. 92-93. Feb., 1910.

—Comment.—**J. L. Malm**. Vol. 2, pp. 119-20. Feb., 1910.

- 1603 The Malm process. Eng. & Min. Jour., vol. 101, pp. 679-80. April 15, 1916.

Difficulties in electrolytic decomposition of fused zinc chloride, as attempted at the Bunker Hill & Sullivan plant.

—Reply, by **John L. Malm** and **S. A. Ionides**. Vol. 101, pp. 864-65. May 13, 1916.

- 1604 The theory of dry chlorination of sulphide ores.—**F. W. Traphagen**. West. Chem. & Met., vol. 5, pp. 89-90. March, 1909.

PATENTS ON ELECTROLYSIS OF FUSED MATERIALS

United States

- 1605** 586,159. Process of treating zinc-sulphide ores.—**Hugo Brewer**, Duisburg, Germany. Filed Sept. 12, 1896. Issued July 13, 1897.

The process of treating zinciferous sulphate lyes resulting from the lixiviation of chlorinated roasted zinc-sulphide ores, which consists in treating the lye with sodium chloride to saturation or in excess, crystallizing out the sodium sulphate (Glauber salt) formed by refrigeration, treating the lye after removal of the sulphate with calcium chloride, removing the calcium sulphate formed, eliminating from the lye the silver, if any be present, then the iron and successively the other metals if present, as nickel, cobalt and manganese, concentrating the lye by heat, eliminating the sodium chloride formed, treating the resultant lye electrolytically for the extraction of zinc under simultaneous production of chlorine, whereby a final lye is obtained consisting essentially of a solution of calcium chloride and recovering the latter for use in the process.

- 1606** 629,686. Process of extracting zinc from its ores.—**Carl Hoepfner**, Frankfort-on-the-Main, Germany. Filed November 18, 1897. Issued July 25, 1899.

The process which consists in oxidizing roasting zinciferous sulphide material, converting the resulting sulphurous acid into sulphuric acid, causing the latter to react upon a suitable chloride in the presence of heat and reacting with the hydrochloric acid gas thus formed upon the oxidized material in the presence of a metallic chloride solution, whereby a neutral or slightly basic solution containing zinc in the form of a chloride is obtained, and electrolyzing the latter solution.

—Described in *Met. & Chem. Eng.*, vol. 11, p. 59. Jan., 1913.

- 1607** 642,933. Electrolytic separation of zinc from zinc oxide.—**Oscar J. Steinhart, Julius L. F. Vogel and Henry E. Fry**, London, England. Filed April 10, 1899. Issued Feb. 6, 1900.

The process of separating zinc from zinc oxide, which consists in dissolving zinc oxide in molten zinc chloride mixed with sodium chloride, heating the zinc chloride to a temperature just above the melting-point of zinc, passing an electric current of low voltage through the molten mixture between a layer of molten zinc at the bottom, forming the cathode, and a conductor which dips into the molten mixture of zinc chloride and oxide, and forms the anode, and adding from time to time fresh zinc oxide to the vessel as oxide is decomposed by the current.

- 1608** 679,997. Electrolytic process of obtaining metals from their fused compounds.—**George P. Scholl**, Philadelphia, Pa. Filed Nov. 14, 1898. Issued Aug. 6, 1901.

The process of obtaining metals by electrolysis of their fused compounds, which consists in fusing a bath composed of a mixture of sulphide of the desired metal with a more fusible compound of said metal which is convertible into sulphide by nascent sulphur; subjecting the fused bath to electrolysis by the action of suitable electrodes under a current which will decompose the sulphide only; and continuously renewing the bath by addition of the other constituents in proportion as the metal ingredient is liberated at the cathode.

- 1609 691,822. Extraction of metals from sulphide ores by treatment with chloride of sulphur and electrolysis.—**James Swinburne and Edgar A. Ashcroft**, London, England. Issued Jan. 28, 1902.

The process consists in treating sulphur ores in a fused haloid salt with chloride of sulphur and producing sulphur and chloride; electrolyzing the chloride, thereby producing chlorine and metal, and combining the chlorine with some of the sulphur from the treatment of the sulphide ore using the so-regenerated sulphur chloride for treating more ore.

- 1610 695,126. Process of extracting metals from sulphide ores.—**James Swinburne and Edgar A. Ashcroft**, London, England. Filed Dec. 8, 1899. Issued March 11, 1902.

The process consists in treating sulphide ores, suspended in a bath of fused chloride or chloride with chlorine.

- 1611 814,810. Metallurgical process.—**Frederick T. Snyder**, Oak Park, Ills. Filed June 23, 1905. Issued March 13, 1906.

The process of treating sulphide ore which consists in dissolving the same in a fused-mineral bath, and subjecting the mixture to the action of an electric current in the presence of carbon at a high temperature, the sulphide being broken down, the metal thereof liberated and carbon bisulphide formed at the same time by the reaction of the sulphur and carbon. 12 claims.

- 1612 841,103. Process of treating ores.—**Charles E. Baker and Arthur W. Burwell**, Cleveland, Ohio. Filed March 1, 1905. Issued Jan. 15, 1907.

The process which consists in reacting with dry sulphur chloride upon dry pulverent sulphide at a suitable temperature, thereby separating sulphur and producing the chloride of the metal or metals of the ore, extracting the metallic chloride, and electrodepositing the metal.

- 1613 1,011,897. Treatment of complex ores.—**Edgar Arthur Ashcroft**, Sogn, Norway. Filed April 9, 1910. Issued Dec. 19, 1911.

The process of separating metals from zinc sulphide containing other metallic sulphides, which consists in the reaction of zinc chloride with said metallic sulphides in the fused state to precipitate zinc sulphide and dissolve the other metals, pouring off the melt from the residue to separate the liquid melt consisting of zinc chloride having in solution chlorides of the other metals from the solid residual zinc sulphide, thereafter treating the melt to recover

the metals therefrom, performing the separation in two or more stages in cascade, the fused melt passing in one direction and the solid residue being moved in the other direction, washing rapidly the residue with hot water to remove soluble chlorides such as zinc and other metal chlorides therefrom, and adding the solution of chlorides to the melt. 14 claims. Patented also in England, no. 6670 of 1910.

—Described in Met. & Chem. Eng., vol. 10, p. 117-119. Feb., 1912.

- 1614 1,011,898. Metallurgy of zinc-bearing lead sulphides with or without small admixtures of other metals.—**Edgar Arthur Ashcroft**, Sogn, Norway. Filed April 9, 1910. Issued Dec. 19, 1911.

A process of recovering lead from lead sulphide containing zinc and other sulphides which consists in treating the ore with a fused metallic chloride to dissolve the lead and to form a chloro-sulphide, and separating and electrolyzing said chloro-sulphide separate from the zinc containing minerals. 10 claims. Patented also in England, no. 7329 of 1910.

- 1615 1,011,899. Metallurgy of metal sulphides.—**Edgar Arthur Ashcroft**, Sogn, Norway. Filed April 9, 1910. Issued Dec. 19, 1911.

A process of treating sulphide ores or products which consists in eliminating the gangue matter, separating the lead and silver present, mixing the remaining product with a fused metal chloride, subjecting the melt to the action of a chlorinating agent, removing the melt to other converters, treating the mixture with chlorine to volatilize the iron and manganese as higher chlorides, passing the chlorides to absorption apparatus wherein they are treated with a solution of sodium hydrate to form sodium chloride and iron and manganese hydrates, separating and electrolyzing the sodium chloride for the production of chlorine and sodium hydrate, utilizing the chlorine for reacting with the mixed sulphides and chlorides in the first converter and the mixed chlorides in the second converters, passing the sodium hydrate to the absorption apparatus to react with the iron and manganese chlorides, and thereafter recovering the other metals present by extracting them by fractional precipitation and electrolysis. 14 claims. Patented also in England, no. 7,444 of 1910 and no. 7,536 of 1910.

- 1616 1,011,900. Metallurgy of metal sulphides.—**Edgar Arthur Ashcroft**, Sogn, Norway. Filed April 9, 1910. Issued Dec. 19, 1911.

A process of recovering zinc from a mixture containing zinc sulphide which comprises treating the mixture with fused zinc chloride, electrolyzing the melt over a bath of molten lead so as to remove the iron as an alloy, subsequently electrolyzing the melt at low temperature to produce zinc and chloride of sulphur, and reacting the chloride of sulphur with a mixture containing the zinc sulphide to form zinc chloride and sulphur, the zinc chloride being added to the electrolytic bath.

—Described in Met. & Chem. Eng., vol. 10, p. 117-119. Feb., 1912.

- 1616a** 1,049,746. Process of treating metal and mineral bearing materials.—**John L. Malm**, Denver, Colo. Filed Aug. 9, 1909. Issued Jan. 7, 1913.

Consists in subjecting the material to the action of a halogen gas in a receptacle for a sufficient length of time to deliver salts of a part only of the metal or metals in the "ous" condition, and introducing into the receptacle with the gas a cooling agent. 21 claims.

- 1617** 1,066,787. Process of producing zinc from blue powder.—**Warren F. Bleeker**, Cannonsburg, Pa. Filed Jan. 22, 1913. Issued July 8, 1913.

Consists in removing the coating of the particles of the powder and fusing the uncovered zinc particles by placing the blue powder in a receptacle containing a suitable electrolyte, electrolyzing the latter with a direct electric current, and subjecting the receptacle to heat of fusing temperature.

- 1618** 1,254,531. Method or process of smelting zinc.—**Isak Par-tanen**, Telluride, Colo. Filed Feb. 2, 1916. Issued Jan. 22, 1918.

The method of electrolytically smelting zinc, which consists in chloridizing "blue powder" with chlorine, fusing the zinc chloride and hypochlorite thus produced and then electrolyzing the said zinc chloride and hypochlorite to separate the pure metal.

Great Britain

- 1619** 11,724 of 1894. Improvements in the treatment of calamine or similar minerals or compounds for the extraction of zinc.—**Carl Hoepfner**, Giessen, Germany.

"The calamine or similar mineral is finely powdered and treated with a strong solution of calcium chloride at a high temperature and under pressure. The zinc solution thus obtained is electrolyzed in an apparatus fitted with insoluble anodes from which chlorine is liberated. Only a portion of the zinc is thus precipitated, the remainder being precipitated chemically, preferably by means of hydrate of lime."—J. S. C. I.

- 1620** 25,074 of 1894. Process and apparatus for the production of zinc and lead by electrolysis of the melted chlorides.—**R. O. Lorenz**.

"To effect the working of ores or residues or alloys containing zinc and lead by converting them into chlorides and subjecting them to fractional electrolysis at a temperature of from 450° C to 680° C., with the addition, as may be required, of small quantities of litharge, red lead, peroxide of lead, zinc oxide or other metallic oxides or peroxides or of common salt, potassium chloride, magnesium chloride, sodium fluoride, or other fluxes for preventing frothing and for regulating the process."—J. S. C. I.

—Described in Zeits. f. Elektrochem., vol. 2, pp. 318-27. Nov. 5, 1895.

- 1621 15,813 of 1895. Improvements in and connected with the production of chlorine and zinc.—**F. M. Lyte**, London.

Blende or mixed blende-galena ores may be roasted and leached with dilute sulphuric acid, and the resulting zinc sulphate solution treated with calcium or sodium chloride. The zinc chloride solution is evaporated to dryness, subjected to distillation and then heated to a temperature slightly above the melting point of zinc, and electrolyzed, a carbon anode and fused zinc cathode being used. See also no. 11,190 of 1897.

- 1622 28,764 of 1896. Apparatus for use in electrolysis, more especially intended for use in the electrolysis of zinc chloride.—**F. Hurter** and the **United Alkali Co., Ltd.**, Liverpool.

—Described in Jour. Soc. Chem. Ind., vol. 16, p. 1022. Dec. 31, 1897.

- 1623 10,829 and 10,829 A of 1897. Improvement in the treatment of sulphide ores.—**J. Swinburne**, London.

Treating mixed sulphides with chlorine and depositing the metals by electrolysis of the fused zinc chloride.

—Described in Jour. Soc. Chem. Ind., vol. 17, p. 673. July 30, 1898.

- 1624 11,190 of 1897. Improvements in the electrolysis of fused zinc chloride.—**F. M. Lyte**, London.

Improvement in English Patent no. 15,813 of 1895. Consists in the complete dehydration of the fused zinc chloride before it is electrolysed. The dehydration is effected by digesting the fused zinc chloride in the presence of metallic zinc, preferably fused.

- 1625 19,876 of 1898. Electrolytic separation of zinc from zinc oxide.—**O. J. Steinhardt**, **J. L. F. Vogel** and **H. E. Fry**, London.

"Dissolving zinc oxide in a bath of fused zinc chloride and electrolyzing the fused mass with such a current that the zinc is deposited from the oxide, while the chloride remains undecomposed."—**E. & M. J.**

- 1626 19,878 of 1898. Zinc chloride making.—**O. J. Steinhardt**, **J. F. L. Vogel** and **H. G. Fry**, London.

"Manufacture of anhydrous zinc chloride and the prevention of its hygroscopic qualities."—**E. & M. J.**

- 1627 24,307 of 1898. Electrolytic extraction of zinc and other metals from ores or waste containing them.—**W. Strzoda**, **Kattowitz**.

The pulverized ore, such as calamine, blende, and the like, or waste containing zinc, is exposed to the action of an electric current directly in an alkaline bath (caustic soda) without any preliminary chemical treatment, whereby the zinc and also the other metals present are at once metallicity separated at the cathode.

- 1628** 6,857 of 1901. Treatment of zinc chloride for electrolytic purposes.—**J. Swinburne**, London, and **E. A. Ashcroft**, Milton, England. April 2, 1901.

"Zinc is reduced from the fused chloride by electrolysis, after the zinc chloride has been dehydrated and purified by a preliminary electrolysis."—**J. S. C. I.**

- 1629** 26,813A of 1905. Electrolysis of fused salts.—**E. A. Ashcroft**.

"Improvements in the inventor's method of producing metals by the electrolysis of fused salts or ores, consisting in first electrolyzing the ores or salts over a metal and using the alloy so formed as an anode in another cell and so fractionally precipitating the metals of the alloy on the cathode."—**E. & M. J.**

Germany

- 1630** 245,683. Process for the recovery of zinc by electrolysis from a mixture of zinc sulphide with fused zinc chloride.—**E. A. Ashcroft**, Sogn, Norway. April 12, 1910.

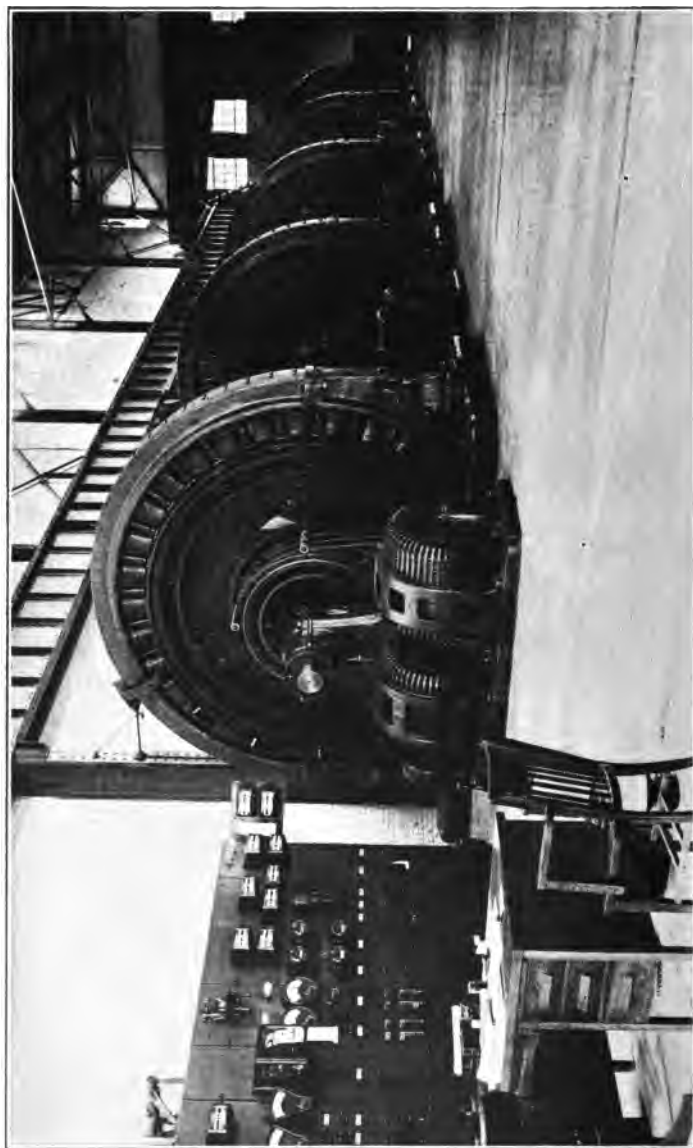
See also item 1577.

—Described in *Zeits. f. Elektrochem.*, vol. 18, p. 792. Sept. 1, 1912.

—Described, with diag., in *Zeits. f. angewandte Chem.*, vol. 25, pp. 982-83. May 10, 1912.

- 1631** 263,942. Electrolysis of fused zinc salts.—**Fabrik Elektrischer Zuender Ges. m. b. H.** Sept. 25, 1912.

Irregularities due to presence of water or zinc hydroxide in the electrolyte are avoided by the addition of aluminium compounds, e. g., aluminium chloride.



SUBSTATION OF GREAT FALLS ELECTROLYTIC ZINC PLANT, ANACONDA COPPER MINING CO.
Showing five 5800-K. W. rotary converters in operation

ELECTROLYSIS OF AQUEOUS SOLUTIONS

Bibliographies

- 1632 Electrodeposition of zinc from aqueous solutions.—**E. P. Mathewson.** *Canad. Min. Inst., Trans.*, vol. 20, pp. 135-60. 1917.

Contains an extensive bibliography, chronologically arranged, prepared by the Library Service Bureau of the United Engineering Societies, New York.

- Same. *Canad. Min. Inst., Bull.* 59, pp. 239-60. March, 1917.

- 1633 Die englischen elektrochemischen Patente.—**P. Ferchland.** Halle, Wm. Knapp, 1907. 176 pp.

Chronologic list of English patents, 1842-1907, on electro-chemistry. No. 29, Monographien ueber angewandte elektrochemie.

- 1633a Extracts from the technical literature (on steel and zinc). *Zeits. f. Elektrochem.*, vol. 22, pp. 305-14. 1916.

"A review of patents covering electrical processes for the production of steel and zinc."—Chem. Abst. In German.

Electrolysis

- 1634 Addition agents in the deposition of zinc from zinc sulphate solution.—**O. P. Watts** and **A. C. Shape.** illus. *Amer. Electrochem. Soc., Trans.*, vol. 25, pp. 291-96. 1914.

The effect of the separate addition of 42 different organic substances to a zinc plating solution. Three very promising agents discovered were eikonogen, pyrogallol, and betanaphthol. Gum arabic, benzoic acid, caffeine, formin, and terpinhydrate gave fair results.

- Abstract. *Met. & Chem. Eng.*, vol. 12, p. 339. May, 1914.

- 1635 Advancement in the metallurgy of zinc.—**M. F. Chase.** *Min. Wld.*, vol. 44, pp. 15-16. Jan. 1, 1916.

Progress during 1915, especially in electrolytic experimentation.

- 1636 Aerating anode. diagr. *Met. & Chem. Eng.*, vol. 18, p. 485. May 1, 1918.

H. R. Hanley's Patent 1,241,967.

- 1637 Antimony in zinc electrolytes.—**H. F. Bradley.** *Met. & Chem. Eng.*, vol. 17, p. 275. Sept. 15, 1917.

Materials and method of determination.

- 1638 Cathodic deposition of zinc in presence of organic bases.—**A. Mazzucchelli.** *Atti. R. Accad. Lincei*, ser. 5, vol. 23, pt. ii, pp. 503-8. 1914.

- Effect of small proportions of salts of quinine, cinchonine, lutidine, aniline, pyridine, gelatin, etc., on the deposition of zinc from a solution of zinc and ammonium sulphates, a pure zinc anode and a brass cathode being used. In Italian.
- Abstract. Jour. Chem. Soc., vol. 108, pt. ii, pp. 670-71. 1915.
- Same abstract. Jour. Soc. Chem. Ind., vol. 34, pp. 1147-48. Nov. 30, 1915.
- 1639** Chemical reactions taking place at the cathode and anode during the electrolysis of simple salt solutions.—**J. H. Patterson.** Durham Univ. Phil. Soc., Proc., vol. 4, pp. 187-220. 1912.
- Abstract. Jour. Soc. Chem. Ind., vol. 31, p. 1040. Nov. 15, 1912.
- 1640** The conductivity and ionization of electrolytes in aqueous solutions as conditioned by temperature, dilution and hydrolysis.—**H. C. Jones** and **C. A. Jacobson.** graphs. Amer. Chem. Jour., vol. 40, pp. 355-410. Oct., 1910.
- “Investigations to supply data upon the influence of temperature upon dissociation.”
- 1641** Die Darstellung des Zinks auf elektrolytischem Wege.—**Emil Guenther.** Halle, Wm. Knapp, 1904. 245 pp., illus.
- Electrolytic zinc recovery. Monographien ueber angewandte Elektrochemie, Band 16.
- Reviewed in Zeits. f. Elektrochem., vol. 11, pp. 55-56. Jan., 20, 1905.
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- 1642** The deposition of zinc from zinc chloride dissolved in acetone.—**H. E. Patten.** graphs. Jour. Phys. Chem., vol. 8, pp. 483-87. Oct., 1904.
- Author concludes that this method is not well adapted to produce chemically pure zinc, or to give a thick coat for chemical purposes.
- 1643** Diaphragm for electrolytic tank. Eng. & Min. Jour., vol. 98, p. 830. Nov. 7, 1914.
- N. V. Hybinette advises two perforated lead plates, with loose asbestos between them.
- 1644** Die direkte elektrolytische Verarbeitung von Erzen und Huettenprodukten.—**W. Borchers.** Berg- u. Huetten. Zeitg., vol. 52, pp. 251-53, 269-71. July 28, Aug 11, 1893.
- 1645** Les echos de l'electrometallurgie du zinc.—**Rene Sylvany.** Metaux et Alliages, vol. 7, No. 9, pp. 2-4. 1914.

- Electrolytic refining and extraction. Siemens-Halske, Cowper-Coles, Hoepfner, Dieffenbach and other methods.
—Abstract: Electrolytic zinc. Jour. Inst. Metals, vol. 12, pp. 317-18. 1914.
- 1646 Einiges ueber elektrolytische Metallproduktion auf nassen Wege, insbesondere ueber Zinkdarstellung.—**Wilhelm Strzoda**. Chem. Zeitg., vol. 27, pp. 741-43. 1903.
The ore is placed on the cathode, instead of at the anode, in an electrolyte of caustic soda.
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- 1647 Electrodeposition du zinc.—**E. Andreoli**. L'Electricien, vol. 12, pp. 99-102. 1896.
- 1648 The electrodeposition of metals.—**W. Lash Miller**. Amer. Electrochem. Soc., Trans., vol. 23, pp. 17-23. 1913.
General discussion and review of the development of ideas and theories to present stage.
- 1649 Electrodeposition of zinc.—**Ralph C. Snowden**. Amer. Electrochem. Soc., Trans., vol. 11, pp. 121-34. 1907.
An experimental investigation of the conditions affecting the quality of electrolytically deposited zinc. The variables considered were concentration, degree of acidity and alkalinity, reducing agent, current density and temperature.
—Abstract. Electrochem. & Met. Ind., vol. 5, pp. 222-23. June, 1907.
- 1650 L'electrolyse des solutions de zinc, a Broken Hill. L'electricien, vol. 16, pp. 103-5. 1898.
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Discusses leaching and getting the zinc into solution, and its electrolytic deposition.
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Hall's Patent 1,163,911, for addition of CaCO_3 to zinc chloride or sulphate solutions.
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Porter's Patent 1,167,594, for a revolving electrolytic diaphragm cell, especially applicable to the recovery of zinc from ores containing considerable iron.

- 1655** Electrolytic deposition of lead and zinc as affected by the addition of certain organic compounds.—**S. A. Tucker** and **E. G. Thomssen**. Amer. Electrochem. Soc., Trans., vol. 15, pp. 477-83. 1909.
—Abstract. Electrochem. & Met. Ind., vol. 7, p. 273. June, 1909.
- 1656** The electrolytic deposition of nickel-zinc alloys.—**Eugene P. Schoch** and **Alcan Hirsch**. graph. Jour. Amer. Chem. Soc., vol. 29, pp. 314-24. March, 1907.
"Although zinc has a greater electrolytic solution tension than nickel, a bath which contains much more nickel than zinc yields an alloy containing much more zinc than nickel."
- 1657** Electrolytic deposition of zinc. Met. & Chem. Eng., vol. 17, pp. 438-39. Oct. 1, 1917.
Perreux-Lloyd's Patents 1,235,723-724.
- 1657a** Electrolytic deposition of zinc.—**H. E. Broughton**. illus., graphs. Chem. & Met. Eng., vol. 20, pp. 155-62. Feb. 15, 1919.
"Description of plant and process of the Ducktown Sulphur, Copper & Iron Co., Isabella, Tenn. Preparation of cell-liquor from fumes collected as a sludge in the acid chambers."
- 1658** The electrolytic deposition of zinc.—**J. W. Richards**. Amer. Electrochem. Soc., Trans., vol. 25, pp. 281-90. 1914.
Paper read at joint meeting of the New York Sections of the American Electrochemical Society and the American Institute of Mining Engineers.
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- 1660** Electrolytic extraction of zinc.—**R. C. V. Whitfield**. Iron & Coal Trades Rev., vol. 82, p. 707. 1911.
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- 1661** Electrolytic methods of zinc extraction.—**John B. C. Ker-shaw**. Elect. Rev., vol. 45, pp. 36-37. 1899.
- 1662** Electrolytic practice.—**S. E. Bretherton**. Min. & Sci. Press, vol. 113, pp. 793-94. Dec. 2, 1916.

Shows "how the Western mine owner of the so-called complex ores is going to have the advantage over Eastern zinc producers" through transportation costs and cheap power. Describes recent leaching methods.

- 1663 Electrolytic precipitation of zinc.—**Vilhelm Gruner**. Tidsskrift for Kemi, Farmaci og Terapi, vol. 13, pp. 216-20, 232-36. 1916.

"Zinc is electrolytically precipitated in compact form from pure acid solutions if sufficiently stirred. The zinc concentration may be as low as 2%, and the acid as high as 30%." In Norwegian.

—Abstract. Chem. Abst., vol. 10, p. 3033. Dec. 10, 1916.

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- 1663a The electrolytic precipitation of zinc.—**D. McIntosh**. Royal Soc. of Canada, Trans., vol. 2, pt. iii, pp. 113-119. 1917.

"The experimental work was carried out at Trail." 19 pages of photographic illustrations.

—Abstract. Chem. Abst., vol. 13, p. 210. Feb. 10, 1919

- 1664 Electrolytic process. Met. & Chem. Eng., vol. 18, p. 485. May 1, 1918.

H. R. Hanley's Patent 1,241,966.

- 1665 Electrolytic process for low grade zinc ores.—**Eduardo Sanna**. Eng. & Min. Jour., vol. 89, p. 1106. May 28, 1910.

The material is dissolved by alkaline salts and electrolyzed.

"Obtains compact blocks of zinc by the treatment of electrolytic zinc sponge with pressure and heat combined."

- 1666 The electrolytic production of zinc. Eng. & Min. Jour., vol. 65, p. 336. March 19, 1898.

Editorial briefly reviewing the Ashcroft, Siemens-Halske, Diefenbach, and Hoepfner processes.

- 1667 Electrolytic production of zinc and lead from complex sulphide ore.—**Charles H. Burleigh**. Electrochem. Ind., vol. 2, p. 355-57. Sept., 1904.

"Crushed ore is roasted to produce a maximum of oxide, which is extracted with hot 25% to 40% soda solution." Lead is precipitated with 1.5 to 1.7 volts, and zinc with 2.5 to 7 volts.

See also item 1673.

—Abstract. West. Chem. & Met., vol. 1, pp. 111-12. April, 1905.

- 1668 Electrolytic recovery of zinc. Min. Wld., vol. 36, p. 120. Jan. 20, 1912.

Chitaro Yoshida, in Japan, dissolves the zinc ore in the electrolyte, and from this liquid the zinc is precipitated by electrolysis. To prevent sponginess, carbon is used instead of lead, in the anode.

- 1669** The electrolytic recovery of zinc.—**Walter Stoeger.** illus. Min. Jour., vol. 85, pp. 143-44, 170. Jan. 30, Feb. 6, 1909.
Difficulties and causes of failure of many methods. By this method the "sulphide ores are roasted to oxide or a mixture of oxide and sulphate, and leached with sulphuric acid. Calamine is thus leached directly. The liquor is purified and electrolyzed." Gives details and costs.
- 1670** The electrolytic refining of zinc.—**Otto Steiner.** Elektrochem. Zeits., May, 1908.
Describes the various stages of the operation, and outlines the construction of a commercial plant. In German.
- 1671** The electrolytic separation of zinc, copper, and iron from arsenic.—**A. K. Balls** and **C. C. McDonnell.** Jour. Ind. & Eng. Chem., vol. 7, pp. 26-29. Jan., 1915.
- 1672** Electrolytic separation of zinc from its ores. Elektrochem. Zeits., vol. 10, pp. 1-3. 1903.
"Zinc is dissolved by the action of an alkaline solution of alkali hypochlorite, and can then be electrolytically separated from the solution of alkali zincate and chloride." In German.
—Abstract. Jour. Soc. Chem. Ind., vol. 22, p. 704. June 15, 1903.
- 1673** Electrolytic treatment of zinc sulphides.—**C. H. Burleigh.** Eng. & Min. Jour., vol. 77, pp. 876-77. June 2, 1904.
Mixed lead-zinc ores are electrolyzed in alkaline solution, first for lead and then for zinc. Voltage data is given. A fuller discussion is given above, (item 1667).
—Abstract. Electrochem. & Met. Ind., vol. 2, p. 318. Aug., 1904.
- 1674** Electrolytic zinc. Min. & Sci. Press, vol. 111, p. 950. Dec. 25, 1915.
Editorial.
—Same. Jour. Chem. Met. & Min. Soc. So. Africa, vol. 17, p. 77, Oct., 1916.
- 1675** Electrolytic zinc. Min. & Sci. Press, vol. 112, p. 432. March 25, 1916.
Editorial.
- 1676** Electrolytic zinc.—**L. S. Austin.** Min. & Sci. Press, vol. 112, p. 434. March 25, 1916.
The Nahnsen process; and several patents on details of precipitation.
- 1677** Electrolytic zinc.—**C. A. Hansen.** graphs. Amer. Inst. Min. Eng., Bull. 135, pp. 615-43. March, 1918.
Power characteristics in zinc sulphate electrolysis; current efficiency, corrosion rates, voltage and power requirements; cumulative and non-cumulative impurities; temperature and the stability

- of the zinc cell. Based on work at Bully Hill, and at the Judge Mining and Smelting Co.
- Abstract. *Met. & Chem. Eng.*, vol. 18, pp. 481-82. May 1, 1918.
- Abstract. *Min. Jour.*, vol. 121, pp. 265, 279-80. May 3, 11, 1918.
- 1678 Electrolytic zinc.—**Dorsey A. Lyon.** *Met. & Chem. Eng.*, vol. 14, p. 176. Feb. 15, 1916.
Reply to C. A. Hansen (item 1680), in regard to cost of electrolytic plant.
- 1679 Electrolytic zinc.—**H. A. B. Motherwell.** flow sheet. *Min. & Sci. Press*, vol. 112, pp. 401-3. March 18, 1916.
Bradley-Williams process, originally worked out on the ore of the Rhodesia Broken Hill mine.
- 1680 Electrolytic zinc at Bully Hill.—**C. A. Hansen.** illus. *Met. & Chem. Eng.*, vol. 14, pp. 120-22. Feb. 1, 1916.
Correction of statements in article by Lyon, Ralston and Cullen (item 1715). Costs based on Bully Hill, Butte and Superior. See also item 1678, above.
- Abstract. Cost of zinc extraction in America. *Min. Mag.*, vol. 14, pp. 176-77. March, 1916.
- 1681 Electrolytic zinc dust.—**H. J. Morgan and O. C. Ralston.** *Amer. Electrochem. Soc., Trans.*, vol. 30, pp. 229-39. 1916.
Experiments being carried on in an attempt to produce zinc dust from solutions of zinc on a commercial scale, and the substitution of the zinc made in this manner for zinc dust ordinarily used in precipitation of gold and silver in the cyanide process. "The authors have the method of producing dust by electrolyzing the solution of sulphate, the idea being to make a zinc sponge which easily disintegrates."
- Same. *Met. & Chem. Eng.*, vol. 15, pp. 465-68. Oct. 15, 1916.
- Abstract. *Min. & Sci. Press*, vol. 113, pp. 779-80. Nov. 25, 1916.
- Abstract. *Jour. Soc. Chem. Ind.*, vol. 35, p. 1159. Nov. 30, 1916.
- Abstract. *Min. Mag.*, vol. 15, p. 364. Dec., 1916.
- Abstract. *Jour. Franklin Inst.*, vol. 182, p. 802. Dec., 1916.
- Abstract. *Austral. Min. Stand.*, vol. 57, p. 105, Feb. 15, 1917.
- Abstract. *Jour. Chem. Met. & Min. Soc. So. Africa*, vol. 17, p. 162. March, 1917.
- Abstract. *Sci. Abst. B*, vol. 20, p. 229. July, 1917.
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- Historical note on the process, with technical details of roasting and leaching, deposition, chlorine recovery, description of electrolytic vats, leaching plant, discussion of costs and yield of products; manufacture of bleaching powder.
- Abstract: Production of zinc. *diagr. Electrochem. Ind.*, vol. 1, pp. 357-58. June, 1903.
- Abstract. *diagr. Jour. Soc. Chem. Ind.*, vol. 22, pp. 749-50. June 30, 1903.
- 1683** Electrolytic zinc in eastern Canada.—**E. E. Watts.** *Canad. Min. Inst., Trans.*, vol. 20, pp. 161-67. 1917.
- 1684** Electrolytic zinc in Utah.—**C. A. Hansen.** *Met. & Chem. Eng.*, vol. 17, pp. 570-71. Nov. 15, 1917.
Process of the Judge Mining & Smelting Co., as outlined in its annual report.
- 1685** Electrolytic zinc process. *Austral. Min. Stand.*, vol. 55. p. 264. March 23, 1916.
"Promising results are being obtained in several places in Canada."
- 1686** Electrolytic zinc process at Great Falls. *Min. Jour.*, vol. 116, pp. 19-20. Jan. 13, 1917.
"Condensed description of the course of treatment" at the refinery of the Anaconda Copper Mining Co.
- 1687** Electrolytic zinc process in California. *Met. & Chem. Eng.*, vol. 10, p. 47. Jan., 1912.
Brief note descriptive of the Reed process.
- 1688** Electrolytic zinc; the Reed process.—**E. H. Leslie.** *illus. Min. & Sci. Press*, vol. 110, pp. 17-21. Jan. 2, 1915.
—Abstract. *Electrolytic zinc. Min. Mag.*, vol. 12, p. 108. Feb., 1915.
—Abstract, in German. *Zeits. f. angewandte Chem.*, vol. 28, pt. II, pp. 321-22. June 25, 1915.
- 1689** Electrometallurgy of zinc. *Eng. & Min. Jour.*, vol. 100, pp. 325-26. Aug. 21, 1915.
- 1690** Electrometallurgy of zinc. *Min. Jour.*, vol. 85, p. 460. April 10, 1909.
Presence of iron caused difficulties, and the ore was roasted with coal and limestone, the zinc being burned to oxide. Abstract of article by Campredon in *La Metallurgie*.
- 1691** Electrometallurgy of zinc. *Min. Jour.*, vol. 102, p. 791. Aug. 16, 1913.
G. Gallo substitutes zinc fluoride for chloride in preparing solution.
—Same. *Eng. & Min. Jour.*, vol. 96, p. 601. Sept. 27, 1913.

- 1692 Elektrische Zinkgewinnung. I.—Die Elektrolyse waesseriger Zinkloesung. II.—Die Elektrolyse in Schmelzflusse.—**J. Hess.** diagr. Zeits. f. Elektrochem., vol. 10, pp. 686-93. Sept. 2, 1904.

Electrolysis of aqueous solutions and of fused zinc salts. "A complete review up to 1904." Part III (item 1351) is on electric smelting.

- 1693 Elektrochemie waeseriger Loesungen.—**Fritz Foerster.** Leipzig, J. A. Barth, 1905. 507 pp. illus. diagr.

The first volume of the "Handbuch der angewandte physikalischen Chemie," edited by Georg Bredig.

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- 1695 Elektrolytische Abscheidung von Zink. Metallurgie, vol. 9, p. 490. Aug. 8, 1912.

Electrolytic deposition of zinc from aqueous solution of zinc fluoride, with organic addition agents. J. Matuschek's German Patent 244,930.

- 1696 Die electrolytische Herstellung von Zinkniederschlaegen. Metallurgie, vol. 1, p. 302. July 22, 1904.

E. Goldberg's German Patent 151,366, for electrolytic deposition of zinc by the addition of nitrogenous substances.

- 1697 Elektrolytische Zinkgewinnung.—**V. Engelhardt and M. Huth.** Metallurgie, vol. 7, pp. 1-5. Jan. 8, 1910.

Review of the electrolytic processes for zinc recovery, showing that "chloride processes have proved unremunerative, while practical difficulties have hitherto stood in the way of a successful sulphate electrolysis, chief of which is the want of a satisfactory anode." Siemens-Halske's manganese dioxide anodes have met this difficulty most satisfactorily.

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—Abstract. Jour. Soc. Chem. Ind., vol. 29, p. 159. Feb. 15, 1910.

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- 1698 Elektrolytische Zinkgewinnung.—**Walther Stoeger**. diagr. Oester. Zeits. f. Berg- u. Huettengew., vol. 57, pp. 1-5. Jan. 2, 1909.
- 1699 Elektrolytische Zinkgewinnung nach Choate. Zeits. f. Elektrochem., vol. 1, pp. 104-5. June 15, 1894.
U. S. Patent 512,361.
- 1700 Elektrolytische Zinkgewinnung unter Anwendung unlöslicher Anoden, verbunden mit gleichzeitiger Verwertung des Anodenmaterials.—**J. Rontchewsky**. diagr. Zeits. f. Elektrochem., vol. 7, pp. 21-25, 29-32. July 12, 19, 1900.
Investigation to ascertain whether the insoluble anodes used in the electrolysis of zinc sulphate solutions could be made of further service. For example, a greater expenditure of energy is necessary when the oxygen is allowed to escape than when it is fixed by the material of the anode. Two sets of experiments were made, using lead anodes.
—Abstract. Jour. Soc. Chem. Ind., vol. 19, p. 831. Sept. 29, 1900.
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- 1701 Elektrolytisches Faelen von Zink. Metallurgie, vol. 9, p. 492. Aug. 8, 1912.
- 1702 Elektrolytisches Verfahren zur Gewinnung von Metallen, wie Kupfer, Zink oder Nickel, aus Material, das die Metalle in theils oxydischer und theils sulfidischer Form enthaelt. Diagr. Metall u. Erz, vol. 12, pp. 301-2. July 22, 1915.
N. V. Hybinette's German Patent 285,652.
- 1703 Die Elektrometallurgie des Zinkes.—**Erminio Ferrar's**. Zeits. f. angewandte Chem., vol. 19, pp. 896-97. May 18, 1906.
Abstract of a paper at the Sixth International Congress of applied Chemistry at Rome.
- 1704 Elektrometallurgie in waessriger Loesung: Zink.—**Bernhard Neumann**. Zeits. f. Elektrochem., vol. 15, pp. 456-57. July 1, 1909.
Electrolysis of sulphate solutions.
- 1705 Extraction and electrolysis of zinc from smelter fumes. diagr. Met. & Chem. Eng., vol. 14, p. 104. 15, 1916.
Best's U. S. Patent 1,154,601. Smelter fumes containing 30% to 35% zinc are roasted at a temperature below that of sulphatic roasting, and leached with weak sulphuric acid, giving a very pure electrolyte.

- 1706 Formation of floating metallic films by electrolysis.—**F. Mylius and O. Fromm.** *Ann. der Phys. und. Chem.*, vol. 51, pp. 593-621. 1894.
“During electrolysis of a concentrated zinc sulphate solution, it was observed that the cathode wire became surrounded by a film of metallic zinc floating upon the surface of the solution, the film increasing gradually to a considerable size... Two necessary conditions are, an impure state of the surface of the solution, and the presence of oxygen in the atmosphere above the solution.” In German. See also item 1745.
—Abstract. *Jour. Chem. Soc.*, vol. 66, pt. ii, p. 267. 1894.
- 1707 Fortschritte der Elektrometallurgie.—**Franz Peters.** *Berg- u. Huettten. Zeitg.*, vol. 61, pp. 526-28. 1902.
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Roasting, leaching, and electrolysis. English patent 4432 of 1896.
- 1709 Die Gewinnung von zinc mittels Electrolyse.—**B. Kosmann.** *Berg- u. Huettten. Zeitg.*, vol. 42, pp. 287-90. 1883.
- 1710 Gewinnung von Zink aus schwer schmelzbaren Zinkerzen. Zeits. f. Elektrochem., vol. 5, pp. 201-2. Oct. 27. 1898.
Jones' English Patent 4296 of 1898.
- 1711 Grundlagen und jetziger Stand der elektrolytischen Zinkgewinnung.—**Franz Peters.** *Berg- u. Huettten. Zeitg.*, vol. 60, pp. 587-92, 599-604. 1901.
- 1712 Hall method of zinc electrolysis. *Eng. & Min. Jour.*, vol. 101, p. 263. Feb. 5, 1916.
U. S. Patent 1,163,911; method of maintaining the free ion concentration while electrolyzing zinc sulphate or chloride.
- 1713 The Hoepfner process for electrolytic production of zinc. diagr. *Eng. & Min. Jour.*, vol. 65, p. 252. Feb. 26, 1898.
Describes the apparatus upon which Hoepfner based his first American patents.
- 1714 Hydrometallurgy and the electrolytic precipitation of zinc.—**Floyd Dixie James.** *Missouri School of Mines, Bulletin, Technical Ser.*, vol. 4, No. 1. Aug., 1917. 27 pp. illus.
“The purpose of this bulletin is to collect some of the more important information available on this subject, and to give the results of a series of experiments which were made on a number of typical ores.” Gives analyses of ores used; discusses roasting of sulphide ores, leaching, purification of solution, and electro-deposition.
- 1715 Hydrometallurgy of zinc and lead in 1915.—**Dorsey A. Lyon, O. C. Ralston and J. F. Cullen.** *Met. & Chem. Eng.*, vol. 14, pp. 30-31. Jan. 1, 1916.

- Discusses chiefly electrolytic methods at Trail, Anaconda, Bully Hill, Palo Alto, Silverton, Winnington, Welland, etc.
- Abstract, with comments. Electrolytic refining of zinc. *Canad. Min. Jour.*, vol. 37, pp. 35-36. Jan. 15, 1916.
- Abstract. *Jour. Soc. Chem. Ind.*, vol. 35, p. 182. Feb. 15, 1916.
- 1716** Industrial extraction of zinc by the electrochemical method.
—**I. Escard.** *Rev. Electrique*, July 30, 1907.
Discusses technical aspects; Luckow, Letrange, Siemens-Halske, Hoepfner, Ashcroft and other processes; electrolytic extraction from pyrites, cinders and complex materials, and electrolysis of fused zinc chloride. In French.
- 1717** Isherwood process for refractory zinc-lead ores. *Met. & Chem. Eng.*, vol. 12, pp. 351-52. May, 1914.
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- 1718** Isherwood's zinc process. *Min. Mag.*, vol. 15, p. 103. Aug. 1916.
Formation of the British Electrolytic Zinc Co. Lists Isherwood's English patents, with specifications of his main patent, 21,584 of 1909.
- 1719** Latest development in zinc metallurgy. *Min. Wld.*, vol. 43, p. 659. Oct. 23, 1915.
Brief editorial.
- 1720** Making use of segregation in electrolytic tank. *Eng. & Min. Jour.*, vol. 100, p. 356. Aug. 28, 1916.
Pyne and Green's Patent 1,148,798.
- 1721** Measurements of the cathodic and anodic polarisation of zinc in the presence of organic basis.—**A. Mazzucchelli.** *Atti A. Acad. Lincei*, ser. 5, vol. 23, pt. II, pp. 626-33. 1914.
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- 1722** The metallurgy of zinc. *Min. Jour.*, vol. 104, pp. 241-43. March 7, 1914.
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- 1723** A method of electrolytic production of zinc from its ores.—**S. S. Sadtler.** *Amer. Electrochem. Soc., Trans.*, vol. 1, pp. 141-46. 1902.
- 1724** Neueres ueber Zinkelectrolyse in waessriger Loesung.—**Viktor Engelhardt.** illus., diagr. *Metall u. Erz*, vol. 10, pp. 60-72. Oct. 22, 1912.
Review of the older work in zinc electrolysis, briefly characterizing the main types of processes which have been tried or suggested. More recent progress in greater detail.

- Abstract. Recent progress in electrolytic process for zinc. *Met. & Chem. Eng.*, vol. 11, pp. 43-44. Jan., 1913.
- Abstract: Zinc electrolysis in aqueous solutions. *Min. Jour.*, vol. 99, p. 1047. Oct. 26, 1912.
- Same abstract. *Eng. & Min. Jour.*, vol. 94, p. 933. Nov. 16, 1912.
- 1725 Neuerungen in der Elektrometallurgie des Zinks.—**Franz Peters.** *diagr. Glueckauf*, vol. 51, pp. 584-90, 605-14. June 12, 19, 1915.
Progress in the electrometallurgy of zinc; four pages on electrolysis of aqueous solutions.
- 1726 Notes sur les depots de zinc par voies electrolytiques en solutions aqueuses de fluosilicate de zinc.—**Robert Goldschmidt.** *Rev. d'Electrochem. et d'Electromet.*, vol. 1, pp. 276-77. 1907.
"As the result of numerous experiments on the electro-deposition of zinc from an electrolyte consisting of a solution of hydro-fluosilicic acid of 20° B., exactly neutralized with zinc carbonate, the author found that dense, adherent deposits of a bright grey color, free from the least sponginess, can be obtained by using a rotating cathode and adding some very fine sand to the electrolyte."—J. S. C. I.
- 1727 Notes upon the hydrometallurgical and electrolytic treatment of zinc ore.—**E. E. Watts.** *Met. & Chem. Eng.*, vol. 16, pp. 645-47. June 1, 1917.
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- 1728 Nutzbarmachung des auf elektrolytischem Wege erhalten Zinkschwammes. *Metallurgie*, vol. 7, p. 251. April 22, 1910.
Treatment of electrolytic zinc sponge with sodium nitrate. German patent by E. Sanna.
- 1729 On the employment of electricity in chemical industries.—**Ferdinand Fischer.** *diagr. Dangler's Polytech. Jour.*, vol. 251, p. 418. 1884.
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Discussion of contemporary theories, with results obtained, and tables illustrating arguments.

- 1731a Power data for electrolytic zinc.—**G. H. Clevenger** and **F. S. Mulock.** *graphs. Chem. & Met. Eng.*, vol. 20, pp. 156a-b. Feb. 15, 1919.

Two-page insert showing graphically "the relationships between the principal electrical data involved in the production of electrolytic zinc."

- 1732 Production of zinc coatings electrolytically.—**C. Richter.** *Elektrochem. Zeits.*, vol. 15, pp. 194-98. 1908.

"Lustrous coatings can be obtained electrolytically, at the ordinary temperature, with a current of 1 to 1.5 amperes per sq. decm., and 1.135 to 1.8 volts, from a bath containing 140.23 grms. of crystallized zinc sulphate, 42.59 grms. of ammonium sulphate, and 1.274 grams. of sulphuric acid per litre."—**J. S. C. I.**

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E. Sanna's process.

- 1734 Refining of zinc. *Eng. & Min. Jour.*, vol. 105, p. 1083. June 15, 1918.

- 1735 The relative migration velocities of the ions in complex electrolytes: The zinc-ammonia-sulphate plating solution.—**A. Mutscheller.** *Met. & Chem. Eng.*, vol. 13, pp. 439-42. July, 1915.

- 1736 Stratification of solution as an aid to the purification of electrolytes.—**Francis R. Pyne.** *Amer. Electrochem. Soc., Trans.*, vol. 28, pp. 111-18. 1915.

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—Abstract of discussion: Effect of impurities in electrolyte. *Min. & Sci. Press*, vol. 116, p. 91. Jan. 19, 1918.

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Electrolytic processes of extracting zinc, and their development in Italy.

- 1738 Sur l'application de l'électricité à la métallurgie du zinc.—**E. Letrange**. Soc. Ingen. Civils de France, Mémoires, vol. 34, pp. 602-11. 1881.
- 1739 Treatment of complex lead-zinc ores.—**Marcus Ruthenburg**. Chem. Trade Jour., vol. 54, p. 56. Jan. 17, 1914.
- 1740 The treatment of mixed sulphide ores.—**W. R. Ingalls**. Mineral Industry, vol. 7, pp. 741-49. 1898.
Progress in 1898; electrolytic processes of Hoepfner, Ashcroft, Foerster and Guenther, Cowper-Coles and others. Similar reviews of progress and of processes appear in other annual volumes of the Mineral Industry.
- 1741 Ueber die Destillation und elektrolytische Verarbeitung des Zinkschwammes.—**B. Roesung**. Dingler's Polytech. Jour., vol. 263, pp. 87-94. 1886.
- 1742 Ueber den Einfluss von Kolloidzusätzen auf die kathodischen und anodischen Vorgänge bei der Elektrolyse von Metallsalzlösungen (Blei und Zink).—**R. Marc**. illus. Zeits. f. Elektrochem., vol. 19, pp. 431-44. June 1, 1913.
Effect of colloids as addition agents on the electrical processes at the anode and cathode in electrolysis of metallic salt solutions of lead and zinc. "Effect of gum arabic; gelatine, gum tragacanth, dextrin, starch and albumin on electrolytic deposition from different electrolytes. The results are described in detail and tabulated, but can not be generalized; for whilst colloids act favorably by diminishing the size of grain of the deposit, they frequently have an injurious effect on the coherence and strength of the deposit. In general, colloids appeared to cause an increased liberation of Hydrogen at the cathode, but their effect on anodic reactions varied according to the nature of the electrolyte and of the colloid."—J. S. C. I.
- 1743 Ueber die Elektrolyse alkalischer Zinklösungen.—**Richard Amberg**. Berichte der Deutsch. Chem. Gesell., vol. 36, pp. 2489-94. 1903.
"Zinc can be deposited in a coherent form from its solution in potassium hydroxide without the addition of another electrolyte."
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- 1744 Ueber die elektrochemische Bereitung von Zinkoxydkalilösung.—**Paul Schoop**. diagr. Zeits. f. Elektrochem., vol. 1, pp. 205-8, 247-49. Sept. 15, Oct. 1, 1894.
Electrochemical preparation of zinc-potassium oxide.
- 1745 Ueber die elektrolytische Bildung von Zinkblättern auf Oberflächen.—**H. Freundlich** and **W. Novikow**. Zeits. f. Elektrochem., vol. 16, pp. 394-400. June 1, 1910.
Electrolytic formation of zinc flakes on surfaces. "If commercial zinc sulphate is electrolyzed in a flat dish, with a platinum

point just at the surface of the liquid as the cathode, the zinc separates as a thin lustrous film around the cathode. Oxygen is necessary for the occurrence of the phenomenon... and there must also be on the surface of the electrolyte a film of some insoluble liquid."—J. S. C. I. See also item 1706.

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- 1746 Ueber Zinkelektrolyse mit waesserigen Elektrolyten.—**Ernst Hase**. illus. Berg- u. Huetten. Zeitg., vol. 54, pp. 431-35, 439-43. Dec. 13, 20, 1895.

- 1747 Die Verarbeitung zinkhaltiger Bleiglanze.—**W. Borchers**. Zeits. f. Elektrochem., vol. 2, pp. 277-78. Oct. 5, 1895.

The reduction of zinc-bearing lead ores, by (1) Oxydizing roast at low temperature; (2) Conversion of the zinc into sulphate by treating with sulphuric acid; (3) Lixiviation to extract the sulphate; (4) Electrolysis for metallic zinc; (5) Smelting residue for crude lead; (6) Desilverization.

—Abstract. Jour. Soc. Chem. Ind., vol. 15, p. 362. May 30, 1896.

—Criticism.—**Robert C. Schuepphaus**, and reply by W. Borchers. Zeits. f. Elektrochem., vol. 2, pp. 347-48. Nov. 20, 1895.

Borcher's process was unsuccessful in Colorado, and that of Lungwitz was considered more promising.

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- 1748 Die Verarbeitung der Erze mittelst Elektrizitaet; Zink.—**Martin Kiliani**. Berg- u. Huetten. Zeitg., vol. 42, pp. 250-52. 1883.

- 1749 Verfahren zur elektrolytischen Gewinnung von Kupfer und Zink aus Erzen. Metallurgie, vol. 1, pp. 439-41. Oct. 22, 1904.

Laszczynski's U. S. Patent 757,817. Prevents anodic oxidation by use of insoluble anodes tightly wrapped in a porous or permeable envelope of fabric or other suitable material.

- 1750 Verfahren zur elektrolytischen Zinkgewinnung Zeits. f. Elektrochem., vol. 2, pp. 198-99. Aug. 5, 1895.

Lindemann's process for electrolysis with addition of zinc sulphide.

- 1751 Verfahren zum Haltbarmachen von elektrolytisch gewonnenem Zinkschwamm. Metall u. Erz, vol. 12, pp. 104-5. March 8, 1915.
German Patent 282,234, for making zinc sponge stable.
- 1752 Versuche zur Begründung eines gemeinsamen elektrolytischen Zink- und Bleigewinnungsverfahrens.—**Richard Lorenz.** diagr. Zeits. f. anorgan. Chem., vol. 10, pp. 78-116. 1895.
Simultaneous electrolysis of zinc and lead.
- 1753 Versuche zur Herstellung von reinen Zink.—**F. Mylius and O. Fromm.** diagr. Berichte der Deutsch. Chem. Gesell., vol. 28, pp. 1563-75. 1895.
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—Abstract. Zeits. f. Elektrochem., vol. 2, pp. 220-24. Aug. 20, 1895.
—Abstract: Preparation of pure zinc. Jour. Soc. Chem. Ind., vol. 14, p. 867. Oct. 31, 1895.
- 1754 Verzinkerei. Metallurgie, vol. 1, p. 54. Feb. 8, 1904.
Addition of a double sulphate of aluminum and magnesium to a bath of zinc sulphate to promote electrodeposition of zinc.
- 1755 Von der elektrochemischen Metallindustrie Deutschlands.—**H. Danneel.** Zeits. f. Elektrochem., vol. 8, pp. 137-42. March 6, 1902.
Effect of impurities, especially iron.
—Abstract. Electrical Wld., vol. 39, p. 608. April 5, 1902.
—Same abstract. Jour. Franklin Inst., vol. 154, pp. 31-32. July, 1902.
- 1756 Vorbereitung zinkischen Rohmaterials zur Elektrolyse nach Nahnsen. Zeits. f. Elektrochem., vol. 1, pp. 301-2. Nov. 1, 1894.
Preparing zinc ores for electrolysis. "Ores which, like the upper Silesian ores, contain electro-positive metals such as calcium and magnesium, yield a leach liquor ill suited to electrolysis." The noxious material is eliminated by roasting and leaching.
- 1757 Wet and electrolytic methods of treatment of zinc ores.—**E. E. Watts.** Met. & Chem. Eng., vol. 16, pp. 645-47. June 1, 1917.
Results of investigations carried out on a dense sulphide ore from the Sullivan Mine, Kimberly, B.C., and on various ores at Welland, Ont. Paper before American Chemical Society.
—Abstract. Sci. Abst. B, vol. 20, pp. 273-74. Aug., 1917.
- 1757a Lo zinco elettrolitico. Rassegna Mineraria, vol. 24, pp. 97-100. June, 1918.

- 1758 Zinkoxyd durch Elektrolyse von Zink in Natriumsulfatloesung. *Metallurgie*, vol. 1, p. 371. Sept. 8, 1904.

Production of zinc oxide by electrolysis of zinc in a solution of sodium sulphate.

- 1759 Zur elektrolytischen Zinkgewinnung.—**B. Neumann**. *Chem.-Zeitg.*, vol. 20, pp. 36-38. 1896.

Discusses many of the difficulties in preparing suitable electrolytes, and the processes which have aimed to solve the difficulties.

—Abstract. Electrolytic zinc extraction. *Jour. Soc. Chem. Ind.*, vol. 15, pp. 280-81. Apr. 30, 1896.

—Same abstract. *Eng. & Min. Jour.*, vol. 62, p. 52. July 18, 1896.

- 1760 Zur Elektrometallurgie des Zinks.—**Franz Peters**. *Glueckauf*, vol. 41, pp. 1496-1502. 1905.

The Anaconda-Great Falls Process

See also items 1813-17, 1819, 1822, 1824, 1893-94, 1905-10, 1913, 1913a.

- 1761 Anaconda begins production of electrolytic zinc. *Eng. & Min. Jour.*, vol. 102, p. 587. Sept. 30, 1916.

- 1762 Details of the electrolytic zinc process. *Diagr. Met. & Chem. Eng.*, vol. 18, pp. 549-50. May 15, 1918.

Laist & Elton's Patents 1,255,433-439.

- 1763 Electrolytic zinc.—**W. R. Ingalls**. *Amer. Electrochem. Soc., Trans.*, vol. 29, pp. 347-56. 1916.

Conditions governing production of electrolytic zinc; chemistry of process; description of Anaconda process; commercial and technical limitations.

—Same. *Eng. & Min. Jour.*, vol. 101, pp. 425-28. March 4, 1916.

—Same. *Min. Jour.*, vol. 112, pp. 198-200. March 25, 1916.

—Same. *Min. & Sci. Press*, vol. 112, pp. 439-42. March 25, 1916.

—Same (description of Anaconda plant slightly condensed). *Met. & Chem. Eng.*, vol. 14, pp. 264-65. March 1, 1916.

—Abstract. Electrolytic zinc. *Min. Mag.*, vol. 14, p. 234. April, 1916.

- 1764 Electro-deposition of zinc from aqueous solutions.—**E. P. Mathewson**. *Canad. Min. Inst., Trans.*, vol. 20, pp. 135-60. 1917.

The Anaconda methods are outlined in the first two and one-half pages. The remainder of the article comprises a bibliography.

—Same. *Canad. Min. Inst., Bull.* 59, pp. 239-60. March, 1917.

- Abstract. *Canad. Min. Jour.*, vol. 38, p. 125. March 15, 1917.
—Abstract. *Min. Mag.*, vol. 16, p. 220. April, 1917.
—Abstract. *Min. & Sci. Press*, vol. 114, p. 669. May 12, 1917.
- 1765 Electrolytic zinc. *Min. & Sci. Press*, vol. 111, p. 803. Nov. 27, 1915.
- 1766 Electrolytic zinc production.—**W. R. Ingalls**. *Mineral Industry*, vol. 27, pp. 743-50. 1915.
Chemistry and details of Laist's process at Anaconda; difficulties of electrolysis.

The Ashcroft Process

See also Ashcroft's work on the electrolysis of fused materials.

- 1767 The Ashcroft process for the treatment of mixed lead and zinc sulphide ores.—**W. R. Ingalls**. *Eng. & Min. Jour.*, vol. 66, pp. 488-90. Oct. 22, 1898.
Deposition from sulphate solution. "An account, estimate, and criticism of the process and its practical failure in Australia."
—Abstract. *Jour. Soc. Chem. Ind.*, vol. 17, p. 1153. Dec. 31, 1898.
- 1768 The Ashcroft zinc extraction process at Cockle Creek. *Electrician*, vol. 41, p. 419. July 22, 1898.
Deposition from chloride solution. Description of the method and of the plant, which was put in operation in March, 1897, and during a run of four months produced 150 tons of zinc.
- 1769 The treatment of Broken Hill sulphide ores by wet extraction processes, and the electrolytic deposition of zinc.—**Edgar A. Ashcroft**. *Inst. Min. & Met., Trans.*, vol. 6, pp. 282-337. 1897-98.
Detailed description of author's process, with costs.
—Abstract. *Electrician*, vol. 41, pp. 554-58. Aug. 19, 1898.
—Abstract in German. *Zeits. f. Elektrochem.*, vol. 5, pp. 182-87. Oct. 13, 1898.
- 1770 Verarbeitung zinkischer Erze. *diagr. Zeits. f. Elektrochem.*, vol. 2, pp. 376-77. Dec. 5, 1895.
U. S. Patent 546,873. Addition of ferric chloride and use of an iron anode.

Cowper-Coles' Process

- 1771 Cowper-Coles' electrolytic method for the extraction of zinc from refractory ores. *Elect. Rev.*, vol. 43, pp. 265-67. Aug. 19, 1898.

- 1772 Cowper-Coles process for the treatment of refractory ores. *Elect. Rev.*, vol. 43, pp. 788-89. 1898.
- 1773 The electro-deposition of zinc.—**Sherard Cowper-Coles.** illus., diagr. *Jour. Soc. Chem. Ind.*, vol. 15, pp. 414-17. June 30, 1896.
Deposition of zinc on iron, from a solution of ZnSO_4 , FeSO_4 , and water, using a lead anode.
—Abstract, in German. *Zeits. f. Elektrochem.*, vol. 3, pp. 133-34. Sept. 20, 1896.
- 1774 Electrolytic treatment of complex sulphide ores.—**Sherard Cowper-Coles.** *Electrician*, vol. 44, pp. 81-83, 111-13, 157-59. Nov. 10, 17, 24, 1899.
- 1775 Elektrolytische Verzinkung.—**Sherard Cowper-Coles.** Translated into German by Emil Abel. Halle, Wm. Knapp, 1905. 37 pp., illus. 8°.
Monographien ueber angewandte Elektrochemie, Bd. 18.
- 1776 Elektrolytische Zinkfaellung unter Druck. *Zeits. f. Elektrochem.*, vol. 6, pp. 435-36. Feb. 15, 1900.
Electrolysis under a pressure of 70 atmospheres.
- 1777 Some notes on the electrodeposition of zinc under pressure.—**Sherard Cowper-Coles.** *Electrician*, vol. 44, p. 183. Dec. 1, 1899.
- 1778 Some recent investigations in connection with the electro-deposition of zinc.—**Sherard Cowper-Coles.** illus. *Electrician*, vol. 41, pp. 382-83. July 15, 1898.
Results of experiments on the formation of spongy zinc. "A special cell was used with a revolving aluminum cathode; the zinc was deposited from a sulphate solution, various gases being formed over the cathode during deposition. The best deposits were obtained when coal gas and carbon dioxide were used."—J. S. C. I.
- 1779 Zinkgewinnung aus sulfidischen Zink-erzen. *Zeits. f. Elektrochem.*, vol. 5, pp. 379-80. Feb. 16, 1899.
English Patent 5943 of 1898; electrolytic recovery of zinc from Broken Hill sulphide ores.

French's Process

- 1780 Electrolytic recovery of zinc and manganese. *Met. & Chem. Eng.*, vol. 11, p. 293. May, 1913.
U. S. Patents 1,055,157-158.
- 1781 The electrolytic refinery at Trail, B. C.—**John F. Miller.** Illus. *Min. Wld.*, vol. 39, pp. 57-59. July 12, 1913.
- 1782 Electrolytic refining at Trail.—**T. A. Rickard.** illus., diagr., map. *Min. & Sci. Press*, vol. 113, pp. 903-7, 939-41. Dec. 23, 30, 1916.

Zinc roasting, leaching and electrolytic methods described in detail.

—Comment and corrections.—**Thomas French** and **E. H. Hamilton**. Vol. 114, p. 77. Jan. 20, 1917.

- 1783 Electrolytic zinc at Trail. Min. & Sci. Press, vol. 113, pp. 933-34. Dec. 30, 1916.

Review of events in the development of electrolytic zinc process in British Columbia. Outline of French's process.

—Abstract. Min. Mag., vol. 16, pp. 107-8. Feb., 1917.

- 1784 Electrolytic zinc extraction at Trail, B. C.—**E. H. Hamilton**. Amer. Electrochem. Soc., Trans., vol. 32, pp. 317-19. 1917.

Details of roasting, leaching, purification of electrolyte, construction of electrolytic tanks, and the process of electrolysis.

- 1785 The French electrolytic process. Min. Wld., vol. 45, p. 450. Sept. 9, 1916.

- 1786 The "French" process. Canad. Min. Inst., Bull. 40, pp. 584-86. Aug., 1915.

Excerpt from Nelson Daily News, July 8, 1915.

—Same. French process for electrolytic zinc. Met. & Chem. Eng., vol. 13, pp. 888-89. Dec. 1, 1915.

—Abstract. Electrolytic zinc. Min. Mag., vol. 13, pp. 167-68. Sept., 1915.

- 1787 The French zinc process. Met. & Chem. Eng., vol. 10, p. 112. Feb., 1912.

- 1788 The French zinc process. Min. & Sci. Press, vol. 111, p. 404. Sept. 11, 1915.

- 1789 French's zinc process. Min. Mag., vol. 7, p. 223. Sept., 1912.

Brief note: "Novelty and commercial value are not apparent."

- 1790 The French zinc process.—**W. F. Robertson**. Mex. Min. Jour., vol. 15, No. 6, pp. 38-39. Dec., 1912.

- 1791 The French zinc process at the Standard property, Silverton, B. C. Min. Wld., vol. 44, p. 741. April 15, 1916.

Zinc is dissolved from the roasted ore by means of "bisulphate of soda, to which a little manganosite has been added. The zinc is then precipitated electrolytically."

- 1792 French's process for reduction of zinc-lead ores. Canad. Min. Jour., vol. 36, p. 610. Oct. 1, 1915.

- 1793 French's zinc treatment process. Canad. Min. Jour., vol. 38, p. 124. March 15, 1917.

Excerpt from Victoria, B. C., Daily Times.

- 1794 The future of electrolytic zinc.—**Thomas French**. Amer. Electrochem. Soc., Trans., vol. 32, pp. 321-28. 1917.

A discussion of the comparative merits of the retort and electrolytic processes, with details of costs. The conditions of satisfactory roasting, leaching and depositing pure zinc are considered.

—Same. Met. & Chem. Eng., vol. 17, pp. 647-49. Dec. 1, 1917.

—Abstract. Min. & Sci. Press, vol. 116, p. 159. Feb. 2, 1918.

- 1795 Some of the difficulties of the electrolytic process.—**Thomas French**. Met. & Chem. Eng., vol. 17, p. 37. July 1, 1917.

- 1796 Some problems in the production of electrolytic zinc.—**E. H. Hamilton**. Eng. & Min. Jour., vol. 103, p. 270. Feb. 10, 1917.

Brief abstract from annual report of the Consolidated Mining & Smelting Co. of Canada.

Gillies Process

See also items 1912, 1981.

- 1797 Electrolytic treatment of complex zinciferous ores.—**P. M. Gillies**. Austral. Min. Stand., vol. 58, pp. 199, 213-14. Sept. 27, Oct. 4, 1917.

The Gillies process, at Broken Hill, consists of "coarse crushing the ore; partial roasting, and fuming off of zinc and lead, etc.; dissolving the zinc from this 'fume'; purifying the solutions; electrolysis; and smelting the residues." Detailed description, and comparison with other processes.

—Abstract, in German. Metall u. Erz, vol. 15, p. 169. May 22, 1918.

- 1798 Electrolytic zinc; success of the Gillies process. Austral. Min. Stand., vol. 55, p. 130. Feb. 10, 1916.

- 1798a Treatment of zinciferous ores. Chem. & Met. Eng., vol. 20, pp. 544-45. May 15, 1919.

Australian Patent 6,456 of 1918, by J. H. and P. McP. Gillies. Fume dust from the baghouse, treated with sulphuric acid and barium sulphide, is electrolyzed, using zinc plates as cathodes. Gum arabic insures even deposition of zinc.

- 1799 Verfahren zur Behandlung von zinkhaltigen Erzen und Huettenerzeugnissen. Metallurgie, vol. 7, p. 285. May 8, 1910.

J. H. Gillies' German Patent.

The Siemens-Halske Process

- 1800 The electrolytic precipitation of metallic zinc by electrolysis of sulphate of zinc solutions.—**Siemens and Halske**. Min. Jour., vol. 82, p. 515. Oct. 26, 1907.

Translated from the Revue Chimique.

- 1801 Elektrolitische Gewinnung von Zink aus Kiessabbraenden. Metallurgie, vol. 8, pp. 477-78. Aug. 8, 1911.

German Patent 233,252, for electrolytic recovery of zinc from pyritic residues.

- 1802 Elektrolitische Gewinnung von Zink aus Sulfatloesungen. Metallurgie, vol. 2, 545-46. Nov. 22, 1905.

German Patent 162,785; recommends stronger current at the anode than at the cathode.

- 1803 Enteisening der fuer die elektrolitische Zinkgewinnung bestimmten Zinksulfatloesungen mittels Superoxyden und Zinkoxyd. Metallurgie, vol. 6, p. 695. Nov. 8, 1909.

German Patent 213,004; addition of manganese peroxide for eliminating iron from zinc sulphate solutions intended for the electrolytic recovery of zinc.

—Abstract. Electrolytic recovery of zinc. Min. Jour., vol. 87, p. 304. Nov. 20, 1909.

- 1804 Verfahren zur elektrolitischen Gewinnung von Zink aus Sulfatloesungen. Zeits. f. Elektrochem., vol. 12, p. 74. Jan. 26, 1906.

"By the use of a very small anode, the tendency toward formation of spongy zinc can be overcome."

—Abstract: Electrolytic deposition of zinc. Eng. & Min. Jour., vol. 81, p. 424. March 3, 1906.

- 1805 Zinc recovery from solution. Eng. & Min. Jour., vol. 78, p. 920. Dec. 8, 1904.

The current density at the anode is made very much greater than at the cathode, in order to prevent the spongy formation and the redissolving of the zinc formed. English patent 16,396 of 1904.

- 1806 Zink. Zeits. f. Elektrochem. Vol. 2, p. 646. June 5, 1896.

Aluminium sulphate is used as electrolyte. English Patent 1575 of 1896.

- 1807 Zink. Zeits. f. Elektrochem. Vol. 2, p. 257-58. Nov. 20, 1895.

Process by which compressed air is introduced into the electrolyte. English Patent 13,434 of 1895.

Tainton and Pring's Investigations

See also items 1887, 1898, 1903, 1904, 1976.

- 1808 Electrodeposition and refining of zinc. Met. & Chem. Eng., vol. 11, p. 346. June, 1913.

U. S. Patent 1,059,233. Method of electrolyzing a strongly acid solution of a zinc salt with a current of high density.

- 1809 Electrodeposition of zinc. Eng. & Min. Jour., vol. 96, p. 502. Sept. 13, 1913.

U. S. Patent 1,059,233. Use of a colloidal addition agent.

- 1810 The electro-deposition of zinc at high current densities.—
J. N. Pring and U. C. Tainton. illus., diagr. Jour. Chem.
Soc., vol. 105, pp. 710-24. 1914.
"A systematic investigation of the different factors which regu-
late and influence the deposition of zinc by electrolysis."
—Abstract. Jour. Inst. Metals, vol. 12, p. 323. 1914.
—Abstract. Chem. Abst., vol. 8, p. 2115. June 20, 1914.
- 1811 Electrolytic zinc. Met. & Chem. Eng., vol. 17, pp. 40-41.
July 1, 1917.
U. S. Patent 1,210,017.
- 1812 The influence of the physical condition of metals on cath-
odic overvoltage.—J. N. Pring and J. R. Curzon. Faraday
Soc., Trans., vol. 7, pp. 237-45. June, 1912.
—Abstract. Chem. Abst., vol. 6, p. 2715. Oct. 10, 1912.

Electrolytic Zinc Plants

A list of electrolytic plants, with the capacity of each, may be found in the recent volumes of the U. S. Geological Survey's annual publication, "Mineral Resources of the United States," in the annual volumes of "The Mineral Industry," the "Engineering and Mining Journal," and elsewhere. See also page 353.

- 1813 Anaconda Company's zinc refinery. Salt Lake Min. Rev.,
Oct. 30, 1916. pp. 22-23.
- 1814 Anaconda produces spelter. Eng. & Min. Jour., vol. 100, p.
814. Nov. 13, 1915.
- 1815 Anaconda to build big zinc reduction plant. Min. Wld., vol.
43, pp. 1013-14. Dec. 25, 1915.
Great Falls plant.
- 1816 Anaconda's electrolytic zinc plant. Met. & Chem. Eng., vol.
14, p. 132. Feb. 1, 1916.
- 1817 Anaconda's electrolytic zinc plant. Eng. & Min. Jour., vol.
102, pp. 1103-5. Dec. 23, 1916.
Illustrations only.
- 1818 Electrolytic zinc plant. Min. Wld., vol. 45, p. 412. Sept. 2,
1916.
Judge Mining & Smelting Co., Park City, Utah.
- 1819 Great Falls electrolytic zinc plant. Met. & Chem. Eng., vol.
14, p. 177. Feb. 15, 1916.
- 1820 The Judge zinc plant. Eng. & Min. Jour., vol. 103, p. 832.
May 12, 1917.
Abstract of report of Judge Mining & Smelting Co.

- 1821** Metallurgical improvements in British Columbia.—**E. Jacobs.** Canad. Min. Jour., vol. 37, pp. 251-52. May 15, 1916.
Additions and improvements to plants at Trail, at Britannia Mining & Smelting Co., Britannia Beach, and at Granby Consolidated, Anyox.
- 1822** New experimental zinc plant of Anaconda Co. Eng. & Min. Jour., vol. 100, p. 941. Dec. 4, 1915.
- 1823** Refining metals at Trail, B. C. Canad. Min. Jour., vol. 37, p. 314. July 1, 1916.
Comments of Prof. F. A. Thompson of Washington State College, reprinted from Trail News of June 9, 1916.
- 1824** Washoe reduction works, Anaconda.—**L. S. Austin.** Illus., diagr. Min. & Sci. Press, vol. 112, pp. 195-202, 304-9, 547-55. Feb. 5, 26, April 15, 1916.
Part 1, Roaster plant; part 2, The coarse concentrator and flotation plant; part 3, the electrolytic zinc plant, the leaching plant.



JUDGE MINING AND SMELTING COMPANY
Electrolytic Zinc Plant, Park City, Utah

PATENTS ON ELECTROLYSIS OF AQUEOUS SOLUTIONS

United States

- 1825** 415,576. Electrolysis of zinc, copper, etc. **Werner Siemens**, Berlin, assignor to Siemens-Halske. Issued Nov. 19, 1889.

"Lixiviates the ore with solution of ferric sulphate, chloride or cyanide, which dissolves the metal and is reduced to the ferrous form. Electrolyzes the resulting solution at the cathode, depositing the non-ferrous metal; then reoxidizing the residual solution at the anode to the ferric form..."

—Abstract. Met. & Chem. Eng., vol. 9, pp. 429-430. Aug., 1911.

- 1826** 415,738. Electrolysis of copper, zinc or tin.—**Hermann A. Seegall**, Berlin. Issued Nov. 26, 1889.

"Lixiviates the ores first with ferric chloride and then with a solution capable of dissolving the residual cuprous chloride in the ore. The second solution, plus ferric chloride, may be electrolyzed in an open cell, or at the cathode in a diaphragm cell with ferrous chloride in the anode compartment..."

—Described in Met. & Chem. Eng., vol. 9, p. 430. Aug., 1911.

- 1827** 459,556. Process of electrolytically obtaining zinc.—**Alexander Watt**, London, England. Filed March 22, 1889. Issued September 15, 1891.

The improvement in the art of preparing zinc-bearing ores for electrolysis, which consists in digesting the powdered ore in acetic acid and sulphuric acid, at first separately and afterward jointly, to form an electrolyte.

- 1827a** 460,354. Apparatus for electrolytically separating metals from their ores.—**Werner von Siemens**, Berlin, German, assignor to Siemens & Halske. Filed June 30, 1890. Issued Sept. 29, 1891.

In an electrolytical cell, the combination of a revolving cathode, a trough-shaped anode situated below said cathode, in the trough of which the cathode revolves, a screen permitting the passage of the electrolyte and of electricity and capable of preventing the passage of vibrations of the electrolyte situated between the said cathode and anode, and means for supplying the electrolyte above the screen and for withdrawing the oxidized liquid from the bottom of the trough of the anode. Patented also in Germany, No. 48,959; in Spain, No. 9,318 of 1889; in Italy, No. 25,017; and in Austria-Hungary, Nos. 2,784 and 2,772 of 1890.

- 1828** 473,186. Method of producing metallic zinc.—**Parker C. Choate**, Brooklyn, N. Y. Filed Jan. 5, 1891. Issued April 19, 1892.

The process of producing metallic zinc from its ores, which consists in separating the zinc and the equally volatile and more volatile constituents from the less volatile constituents of the ore

by the use of heat and a reducing agent, then volatilizing and oxidizing the reduced metal, thereby obtaining a condensed oxidized fume, subjecting this fume to a moderate heat in order to expel its soluble contents more volatile than zinc, treating the remaining product with dilute sulphuric acid as a solvent and finally subjecting the resulting solution to the action of an electric current to precipitate the zinc.

—Described in *Met. and Chem. Eng.*, vol. 9, p. 618. Nov., 1911.

- 1829** 475,402. Process of obtaining metallic zinc from sulphite of zinc by electrolysis.—**Theodore Lange**, Brieg, Germany
Filed June 4, 1890. Issued May 24, 1892.

The process of obtaining zinc from its ores, which consists in disintegrating and roasting the ore, mixing it with hot water, moving the body of ore and water through a closed vessel, causing the hot sulphurous gases from the ore-roasting process to move in the opposite direction through the ore, delivering the treated ore and water to a filter, drawing off the resulting solution of zinc sulphite and throwing down the zinc by passing an electric current through the solution.

- 1830** 495,637. Process of extracting zinc by electrolysis.—**Johannes Pfleger**, Frankfort-on-the-Main, Germany. Filed August 24, 1892. Issued April 18, 1893.

The process of obtaining zinc by electrolysis out of a zinc-containing anode which consists in adding to the bath a basic-zinc-salt solution adapted to act as electrolyte, to which basic zinc-salt solution a conducting neutral salt has been added.

—Described in *Zeits. f. Elektrochem.*, vol. 1, p. 19. April 15, 1894.

- 1831** 512,361. Art of producing metallic zinc.—**Parker C. Choate**, New York, N. Y., assignor to the Electrical Zinc Company, of New Jersey. Filed Jan. 21, 1892. Issued Jan. 9, 1894.

The process of producing from an impure solution of zinc salts, a zinc electrolyte free from depositable impurities, which consists in subjecting the solution to the action of an electric current to precipitate and deposit the depositable impurities and neutralizing the acid set free in the bath with an oxidized zinc fume free from its more volatile soluble constituents.

—Described in *Met. & Chem. Eng.*, vol. 10, p. 62. Jan., 1912.

- 1832** 518,711. Producing metallic zinc.—**Parker C. Choate**, New York, N. Y., assignor to the Electrical Zinc Company. Filed Dec. 9, 1891. Issued April 24, 1894.

The process of producing commercially pure metallic zinc which consists in immersing in a zinc sulphate electrolyte containing chlorine, a zinc anode so prepared as to contain no metal which is both soluble in such electrolyte and depositable by zinc upon itself therefrom, and depositing the zinc by electrolysis.

—Described in *Met. & Chem. Eng.*, vol. 10, p. 122. Feb., 1912.

- 1833** 518,732. Art of producing metallic zinc.—**Parker C. Choate**, New York, N. Y., assignor to the Electrical Zinc Company. Filed Jan. 21, 1892. Issued April 24, 1894.

The process of continuously producing metallic zinc by electrolysis, which consists in depositing the zinc from an acidulated solution of a zinc salt, drawing off from the bath the free acid liberated therein, dissolving in such acid oxidized zinc in the state of fume, freed from its more volatile soluble impurities and returning the solution thus formed to the bath from time to time, as required to maintain the electrolyte.

—Described in *Met. & Chem. Eng.*, vol. 10, p. 122. Feb., 1912.

- 1834** 537,179. Electrolysis.—**Henry Blumenberg, Jr.**, Mount Vernon, N. Y. Filed March 30, 1894. Issued April 9, 1895.

The improvement in the art which consists in placing an electrolyte containing a haloid salt in a vat, electrolyzing the same thereby setting free the halogen under pressure in the positive compartment and the base without pressure in the negative compartment, leading the halogen into a gas holder and applying additional fluid pressure therein, and the base into a tank, and bringing the halogen from the gas holder to the tank containing the base.

- 1835** 546,328. Anode for electrolytical apparatus.—**Carl Hoepfner**, Giessen, Germany. Filed March 26, 1894. Issued September 17, 1895.

An anode for electrolytical apparatuses consisting of a conductive substance, the surface of which anode contains in minimo about ten per cent silicium, so as to render such anode proof against the action of liquids or gases to which it may be exposed, particularly against the action of chlorine.

- 1836** 546,873. Process of treating zinc-bearing ores.—**Edgar A. Ashcroft**, Broken Hill, New South Wales. Filed August 17, 1894. Issued Sept. 24, 1895.

The process for the treatment of zinc bearing ores and zinc bearing products, which consists in first leaching the oxidized ore with a solution containing a ferric salt, to precipitate the iron from said solution, and dissolve the zinc, secondly electrolyzing the resulting zinc-bearing solution by first passing it around metallic cathodes to precipitate the zinc from the said zinc bearing solution, and then around iron anodes to impart a ferrous salt to the solution, and subsequently raising the ferrous salt to the ferric state and thereby regenerating the original ferric salt solution.

—Described in *Met. & Chem. Eng.*, vol. 10, p. 322. May, 1912.

- 1837** 582,923. Electrolytic apparatus.—**Alfred E. Hunt**, Pittsburgh. Filed Dec. 4, 1895. Issued May 18, 1897.

- 1838** 585,355. Process of obtaining metallic zinc and copper from ores.—**Charles A. Burghardt** and **Gilbert Rigg**, Manchester, England. Filed June 1, 1896. Issued June 29, 1897.

The improved process of recovering metallic zinc from zinc ores which consists in treating the roasted and ground ores with

an ammoniacal solution, then precipitating the iron dissolved in the resultant liquid by the addition of hydrated oxide of tin, and in finally effecting the electrolytic deposition of the metallic zinc.
—Described in *Met. & Chem. Eng.*, vol 10, p. 570. Sept., 1912.

- 1839 585,359. Process of obtaining porous metals by electrolysis.—**Ludwig Hoepfner**, Berlin. Filed Oct. 5, 1896. Issued June 29, 1897.

An electrolytic process of obtaining a metal plate which consists in electrically precipitating a porous or spongy metal, and stiffening the same by precipitating thereupon a denser metal.

- 1840 592,055. Process of treating ores.—**Ernest C. Ketchum**, Boston. Filed Nov. 21, 1896. Issued Oct. 19, 1897.

The process of treating mixed sulphide ores containing lead and zinc, which consists in first roasting the ores, then subjecting the roasted ores to the action of a solution of caustic alkali in the presence of heat to remove from the ores the lead and zinc, then subjecting the caustic solution containing the lead and zinc to electrolytic action in the presence of heat to remove the lead, in a cell or cells in which the anode is immersed in a solution that is free from lead and that is separated by a porous medium from the electrolyte containing the lead and zinc, and finally subjecting the solution in which the zinc remains to electrolytic action, also in the presence of heat, to remove the zinc, employing electric currents of different electromotive force in effecting the successive decompositions.

—Described in *Met. & Chem. Eng.*, vol. 10, p. 571. Sept., 1912.

- 1841 594,611. Process of and apparatus for removing zinc from zinciferous ores.—**Stephen M. Emmons**, New York. Filed March 6, 1896. Issued Nov. 30, 1897.

The process of treating zinciferous ores which consists in pulverizing and roasting the ore, leaching it in a series of vessels through which the solution flows continuously, and subjecting the contents of each vessel intermittently to electrolytic action, whereby the solution is rendered alternately acid and neutral or more acid and less acid in contact with each body or ore.

—Described in *Met. & Chem. Eng.*, vol. 10, p. 571-72. Sept., 1912.

- 1842 598,180. Apparatus for electrolytically producing zinc.—**Carl Hoepfner**, Giessen, Germany. Filed Oct. 7, 1893. Issued Feb. 1, 1898.

An electrolytic apparatus comprising a vessel containing a zinc-chloride solution, a suitable insoluble anode, and a discoidal revoluble cathode, the latter dipping partly into said solution, means for preventing chlorine bubbles formed at the anode from coming into reactive contact with the cathode and the source of electricity respectively.

- 1843 600,351. Treatment of metalliferous ores and products.—**Edgar A. Ashcroft**, Melbourne, Australia. Filed Feb. 4, 1897. Issued March 8, 1898.

The improved process consisting in circulating a zinc-bearing solution first around the metallic cathodes of a system of vats of an electrolytic apparatus, then around the anodes of the same system of vats, said anodes consisting of the matte of the products resulting from the preliminary furnace treatment of products or ores containing copper and iron, whereby a part or the whole of the zinc content is deposited as metallic zinc and the solution becomes charged with copper and iron, next around the metallic cathodes of another system of vats of the said electrolytic apparatus, and finally around the carbon anodes of the same system of vats of the said electrolytic apparatus, whereby the whole or a part of the copper content is deposited and the iron completely or partially raised to the ferric condition.

—Described in *Met. & Chem. Eng.*, vol. 10, p. 704. Oct., 1912.

- 1844 623,888. Electrodeposition of zinc upon iron.—**Sherard O. Cowper-Coles**, London, England. Filed Dec. 31, 1897. Issued April 25, 1899.

The process of depositing zinc electrolytically and preventing the formation of zinc sponge, by placing in an electrolytic cell containing suitable insoluble anode and cathode plates and electrolyte containing zinc sulphate and iron sulphate and passing through the cell an electric current, the oxygen liberated at the anode when zinc is deposited preventing the formation of hydrogen compounds of zinc or zinc sponge.

- 1845 629,685. Electrolytic production of zinc or other metals.—**Carl Hoepfner**, Berlin. Filed July 16, 1896. Issued July 25, 1899.

A process which consists in placing a lead or copper anode in a solution capable of dissolving the same, placing a suitable cathode in a solution similar to that at the anode but containing also zinc, separating the two solutions by a suitable diaphragm, passing a current from the anode through both solutions to the cathode, thereby bringing lead or copper into solution at the anode and depositing zinc at the cathode, precipitating the lead or copper dissolved in the anode solution by adding a zinc compound thereto and conveying the resulting solution to the cathode compartment.

—Described in *Met. & Chem. Eng.*, vol. 11, p. 59. Jan., 1913.

- 1846 639,579. Process of recovering zinc from refractory zinc-bearing ores.—**John Jones**, East Melbourne, Victoria. Filed Feb. 17, 1898. Issued Dec. 19, 1899.

The process which consists in placing in the anode compartment of a cell having a suitable diaphragm, a mixture of sulphate of zinc and sulphate of ammonium, placing in the cathode-compartment an acid solution containing sulphate of zinc, passing an electric current through both solutions whereby zinc and ammonium are set free at the cathode, and continuously adding to the cathode solution sufficient acid solution containing zinc sulphate to neutralize the ammonium liberated in said solution and to maintain in the solution a low degree of acidity.

—Described in *Met. & Chem. Eng.*, vol. 11, p. 60. Jan., 1913.

- 1847 644,029. Process of electrodeposition of metals.—**Sherard O. Cowper-Coles**, London, England. Filed Aug. 28, 1899. Issued Feb. 20, 1900.

In the electrodeposition of metals, the process consisting in passing an electric current from an anode to a cathode through an electrolyte containing the metal to be deposited, and at the same time rotating the cathode at such a high rate of speed as will cause the hydrogen bubbles to be thrown off from the cathode and give such friction between the metal deposits on the cathode and the electrolyte as to yield tough and smooth deposits.

- 1848 649,151. Apparatus for electrolytically extracting metals from refractory ores.—**Wm. Wright**, N. Y. Issued May 8, 1900.

—Described in *Met. & Chem. Eng.*, vol. 11, p. 60. Jan., 1913.

- 1849 650,646. Apparatus for electrolytic reduction of ores.—**Frederic H. Long**, Chicago, Ills. Filed June 22, 1898. Issued May 29, 1900.

In electrolytic apparatus, the combination with the reducer vessel, of the open partition extended across said vessel, the anode projected past the partition, the terminal cathode, the interposed diaphragm and suitable means for circulating the ore charge between the anode and diaphragm, substantially as described. 9 claims.

- 1850 655,783. Electrolytic apparatus for decomposing metallic salts.—**Carl Kellner**, Vienna, Austria. Filed March 3, 1896. Issued Aug. 14, 1900.

An external vessel for containing an electrolyte, suitable anodes, a mercury cathode suspended above the bottom of said vessel by suitable means, a chambered structure dipping into the cathode, means for moving said structure through the cathode and means for placing one or more chambers of the chambered structure in communication with the external vessel.

- 1851 656,305. Process of electrolytically extracting zinc from ores.—**Wilhelm Strzoda**, Falence, Germany. Filed Jan. 20, 1899. Issued Aug. 21, 1900.

The process consists in placing the disintegrated ore in its natural state in an electrolytic vat containing an aqueous alkali-metal solution capable of dissolving the ore with the production of a zincate and in direct contact with the cathode and closing the circuit through the vat, thereby precipitating zinc and the alkali metal at the cathode, the alkali metal reacting with the water, to regenerate the solvent solution.

—Described in *Met. & Chem. Eng.*, vol. 11, p. 116. Feb., 1913.

- 1852 657,646. Apparatus for reclaiming tin and zinc from tinned and zinc scrap.—**George B. Cruickshank**, Birmingham, **Herbert R. S. Coleman**, Smethwick, and **Percival Cruickshank**, Birmingham, England. Filed May 23, 1900. Issued Sept. 11, 1900.

In apparatus for reclaiming tin or zinc from tinned or zinc scrap by the use of a chemical solution and electricity, the combination of a vat, having suspended therein a revoluble reel with flanges carried in bearings, with the circumferential revoluble perforated anode-drums journaled, such drums and their interiors being connected to the positive pole of a battery or dynamo, and the cathode-plates connected to the negative pole of a battery or dynamo.

- 1853 664,269. Process of recovering zinc.—**Carl Hoepfner**, Frankfort-on-the-Main, Germany. Filed Nov. 18, 1897. Issued Dec. 18, 1900.

The process which consists in reacting upon zinc carbonate or a material containing it, with a solution of calcium chloride at a temperature above normal and a pressure above atmospheric recovering a portion of the zinc electrolytically and the remaining zinc as a hydroxide by means of lime, concentrating the solution and returning it into the cycle of operations. 7 claims.

—Described in *Met. & Chem. Eng.*, vol. 11, p. 116. Feb., 1913.

- 1854 665,953. Process of electrolyzing soluble salts.—**Antoine J. O. Chalandre** and **Louis J. B. A. Colas**, Paris, and **Charles Gerard**, Seveux, France. Filed March 21, 1899. Issued Jan. 15, 1901.

The process consists in passing an electric current through a soluble salt from an anode to a cathode, combining, outside of the apparatus, part of the gases from the cathode and anode compartments, to form an acid, then introducing the acid thus formed into the anode compartment, where it immediately decomposes to counteract or annul detrimental secondary reactions and liberate or recuperate the gas evolved at the positive pole which has served in the formation of the acid.

- 1855 669,926. Process of electrolytical extraction of metals.—**Carl Hoepfner**, Frankfort-on-the-Main, Germany. Filed Sept. 27, 1899. Issued March 12, 1901.

A process which consists in placing a lead or copper anode in a solution capable of dissolving the same, placing a suitable cathode in a solution similar to that at the anode but containing also zinc, containing however no metal more electronegative than zinc, interposing a similar third solution of less solution-pressure than that at the cathode, separating the solutions by suitable diaphragms, maintaining their temperature above normal, passing a current from the anode through the solutions to the cathode, thereby bringing the lead or copper into solution at the anode and depositing zinc at the cathode, precipitating the lead from the anode and intermediate solution by means of zinc oxide and carbonic acid and conveying the resulting solution to the cathode-cells.—12 claims.

—Described in *Met. & Chem. Eng.*, vol. 11, p. 171. March, 1913.

- 1856 674,809. Process of treating zinc-bearing ores for obtaining zinc, etc.—**Sherard O. Cowper-Coles**, London, England, assignor to the Cowper-Coles Metal Extraction Syndicate.

Ltd., Mellanear Haeyle, England. Filed July 23, 1898. Issued May 21, 1901.

A process for the treatment of complex zinc ores, such as those known as "Broken Hill" ore, consisting in mixing with the said ore prior to the roasting a quantity of zinc blende, copper sulphide ore or tin ore tailings thereof, then roasting it to a "dead roast" then crushing and screening it and placing it in vats where it is leached with a weak solution of sulphuric acid to abstract the zinc and copper, then passing such solution containing zinc sulphate and copper sulphate through a body of carbon and an electropositive metal to recover the copper and then electrolyzing the remaining solution to recover the zinc; the said leaching solution after its strength has been adjusted, being returned to the leaching-vats for use over again. 6 claims

1857 678,816. Process of recovering zinc.—**Albert J. Shinn**, Philadelphia, Pa. Filed June 4, 1900. Issued July 16, 1901.

The process of recovering zinc from a solution of any of its compounds, said process consisting of electrolytically decomposing said solution, collecting the zinc thrown out as an amalgam upon a stream of mercury flowing over a metal plate, separating the thick or pasty amalgam from the surplus mercury and liquid amalgam during the operation of the process, and returning this liquid to be used repeatedly in the above process.

1858 690,295. Process of extracting zinc from waste products of roasted pyrites.—**Carl Kellner**, Vienna, Austria-Hungary. Filed Oct. 13, 1900. Issued Dec. 31, 1901.

Consists in converting the zinc compounds into sulphite of zinc by means of sulphurous acid, converting the sulphite into sulphate of zinc, mixing therewith a chloride of a metal of the alkalies or alkaline earth, thereby forming chloride of zinc and sulphate of an alkali metal, placing therein suitable electrodes and passing an electric current, thereby depositing zinc at the cathode and liberating chlorine at the anode. 6 claims. Patented also in England, no. 7028 of 1900.

--Described in Jour. Soc. Chem. Ind., vol. 20, p. 367. April 30, 1901.

1859 692,531. Electrolytic cell.—**Ernest A. Le Sueur**, Rumford Falls, Me., assignor to the Electro-Chemical Company. Issued Feb. 4, 1902.

1860 697,831. Method of recovering metals by electrolysis.—**Hans A. Frasch**, Hamilton, Canada. Issued April 15, 1902.

A process of recovering metals by electrolysis which consists in electrolyzing a double salt of ammonia and metals whose hydroxides are soluble in ammonia, in the presence of a soluble anode and an anode electrolyte (anolyte) containing metals different from the one contained in the cathode electrolyte (catholyte) but free from ammonia.

1861 700,563. Process of extracting metals from ores and scrap containing same.—**Samuel S. Sadtler**, Philadelphia, Pa. Filed July 10, 1900. Issued May 20, 1902.

The process of obtaining zinc from sulphide ores, said process consisting in treating said ores with a solution formed by treating a caustic alkali with one of the halogens and decomposing the resulting solution in an electrolytic cell, the metal being deposited on a suitable cathode.

—Described. *Met. & Chem. Eng.*, vol. 11, p. 226. April, 1913.

- 1862 701,215. Method of obtaining zinc by electrolysis.—**Ludwig Mond**, London, England. Filed Aug. 12, 1901. Issued May 27, 1902.

A method of obtaining zinc in a solid metallic condition which consists in depositing the zinc on separate cathodes by electrolysis and simultaneously therewith subjecting the deposited zinc upon one cathode to a longitudinal and transverse rubbing action of the zinc deposited upon the other cathode under pressure.

- 1863 701,216. Apparatus for obtaining zinc by electrolysis.—**Ludwig Mond**, London, England. Filed March 4, 1902. Issued May 27, 1902.

An apparatus for obtaining zinc by electrolysis, the combination of a number of cylindrical cathodes rotating in contact with each other within an electrolytic bath, means for pressing the cylinders against each other and means for producing a longitudinal rubbing action between the cylinders.

- 1864 703,857. Electrometallurgical treatment of zinc ores and especially blende.—**Constantin J. Tossizza**, Paris, France. Filed Aug. 6, 1901. Issued July 1, 1902.

For the electrolysis of the sulphate and other salts of zinc, the process whereby a practical reduction of the voltage below two and three-tenths is obtained by the aid of sulphurous acid as a depolarizer, the said process being divided into two parts to avoid the decomposition of said sulphurous acid and consisting as to one part in the electrolysis of the zinc salt with corresponding solution of copper anodes and formation of copper salt, and as to the second part in the electrolytic reconstitution of the said copper anodes by decomposition of the so-formed copper salt in a solution primarily charged with sulphurous acid. Patented in England, no. 14,825 in 1901.

—Described in *Met. & Chem. Eng.*, vol. 11, p. 301. May, 1913.

- 1865 736,565. Process of zincing objects by electrolysis.—**Ignaz Szirmay**, Budapest, Austria-Hungary. Filed Nov. 12, 1900. Issued Aug. 18, 1903.

The method of zinc-plating objects which consists in placing such objects as cathode with a suitable anode in an electrolyte of an aqueous solution of a zinc salt, dextrose and a mixture of sulphates of aluminium and magnesium and passing an electric current. Patented also in England, no. 19,659 of 1900.

- 1866 742,442. Process of electrodepositing metals.—**Woolsey M. Johnson**, Hartford, Conn. Filed Jan. 13, 1903. Issued Oct. 27, 1903.

The method which consists in subjecting the electrolyte in the neighborhood of the cathode to such pressure as will remove contained gases, and electrodepositing a metal therefrom in reguline form. 10 claims.

- 1867 742,443. Electrolytic apparatus.—**Woolsey M. Johnson**, Hartford, Conn. Filed Jan. 13, 1903. Issued Oct. 27, 1903.

- 1868 745,378. Electrolytic refining of zinc.—**Heinrich Paweck**, Vienna, Austria-Hungary. Filed March 7, 1902. Issued Dec. 1, 1903.

The electrolytic process of depositing zinc by electrolyzing in a bath containing zinc salts, conductive salts and boron compounds. Patented also in England, no. 1688 of 1902; in France, no. 318,163.

- 1869 757,817. Process of electrically extracting copper and zinc from ores.—**Stanislaw Laszczynski**, Kielce, Russia. Filed Oct. 10, 1902. Issued April 19, 1904.

Process for electrolytically obtaining metals, especially copper and zinc, out of their ores by means of insoluble anodes, consisting in tightly wrapping the insoluble anode in a porous and perfectly permeable envelope or other suitable material, the thickness of which is in inverse proportion to the applied density of current, for the purpose of preventing anodic oxidation of the cathodes. See also item 1749.

- 1870 791,401. Process of extracting zinc from its ores.—**Anson G. Betts**, Troy, N. Y. Filed Feb. 20, 1905. Issued May 30, 1905.

The process of extracting zinc from its ores which consists in extracting zinc therefrom as a solution of zinc sulphate, electrolyzing the solution with a mercury cathode for the production of a zinc-mercury alloy, and extracting zinc from the alloy and depositing zinc on a suitable cathode by electrolysis of a solution of zinc chloride.

- 1871 798,790. Electrolytic process.—**Carl Hering**, Philadelphia, Pa. Filed July 13, 1901. Issued Sept. 5, 1905.

In an electrolytic process in which there exists in solution in the electrolyte an ingredient which is objectionable because hindering the desired electrolysis, the method of making such objectionable ingredient inert which consists in electrolyzing the solution with an electrode of a material with which said ingredient will combine to form a chemical compound which is inert in the desired electrolytic process and is thereby removed from further action. Zinc is deposited from an electrolyte containing its salt or sulphate, by using an anode of spongy lead. 21 claims.

- 1872 831,843. Process for the electrolytic production of zinc.—**Victor Engelhardt**, Vienna, Austria-Hungary, assignor to Siemens & Halske Aktiengesellschaft Berlin. Germany. Filed Sept. 14, 1904. Issued Sept. 25, 1906.

The process for the electrolytic production of zinc from sulphate solutions which consists in employing at the anode a current

density of from twenty to fifty times that of the current density at the cathode. Patented also in England, no. 16,396 of 1904.

—Described in *Electro. Chem. & Met. Ind.*, vol. 4, pp. 416-17. Oct., 1916.

- 1873 905,785. Electrolytic solution for zinc plating.—**Celestino Bianco**, New York, N. Y. Filed July 16, 1907. Issued Dec. 1, 1908.

An electrolyte for the electro deposition of zinc, containing compounds of zinc and iron and an organic-acid salt of an alkali metal.

- 1874 923,411. Manufacture of zinc dust.—**Sherard O. Cowper-Coles**, London, England. Filed Aug. 2, 1907. Issued June 1, 1909.

A process for the production of zinc dust, consisting in electro-depositing zinc from a caustic soda solution upon a revolving disk upon which the zinc is deposited in the form of a sponge and is continuously removed, and in then drying the spongy zinc so produced in a reducing atmosphere. Patented also in England, no. 13,977 of 1907.

- 1875 935,109. Apparatus for the electrolysis of aqueous solutions.—**Max Huth**, Charlottenburg, near Berlin, Germany, assignor to Siemens & Halske, A.-G., Berlin. Filed Jan. 5, 1909. Issued Sept. 28, 1909.

In an apparatus for the electrolysis of aqueous solutions such as zinc sulphate solutions or solutions of other sulphates, an anode consisting of massive, artificially produced peroxide of manganese, coated (or not) with ceresin, and free from constituents susceptible to the action of the electrolyte. 6 claims.

- 1876 935,250. Electrolytic winning of zinc from solutions of zinc sulphate.—**Victor Engelhardt** and **Max Huth**, Charlottenburg, Germany, assignors to Siemens & Halske, Aktiengesellschaft, Berlin. Filed May 25, 1907. Issued Sept. 28, 1909.

In the process of electrolytically obtaining zinc from sulphate solutions, the process of preventing re-dissolution of the zinc deposit which consists in employing for the electrolysis an anode of compact lead peroxide free from constituents soluble in the electrolyte. Patented also in France, no. 375,140.

—Described in *Metallurgie*, vol. 7, p. 1. Jan. 8, 1910.

—Described in *Min. Mag.*, vol. 2, p. 123. Feb., 1910.

—Described in *Min. Mag.*, vol. 2, p. 314. April, 1910.

- 1877 961,514. Process for treating zinciferous substances.—**Guido Mojana**, Milan, Italy. Filed Dec. 14, 1906. Issued June 14 1910.

A process for the treatment of zinciferous substances at a comparatively low temperature, consisting in subjecting the same to the action of chlorine in the presence of porous carbon and

steam, removing the carbon from the mass thus obtained, lixiviating, filtering, and treating the liquid residuum with oxidizing agents and substances containing oxide of zinc, to obtain zinc chloride, and electrolyzing the zinc chloride to obtain metallic zinc. Patented also in England, no. 28,575 of 1906.

- 1878 967,200. Electrolyte and method of electro-depositing zinc.—**Edward F. Kern**, Knoxville, Tenn., assignor of one-half to Percy S. Brown, New York, N. Y. Filed Sept. 1, 1909. Issued Aug. 16, 1910.

The herein described process of electrodepositing zinc which consists in electrolyzing a solution containing fluosilicate of zinc, fluo-silicate of a metal which stands higher in the solution pressure series than zinc, an organic addition agent (grape-sugar), and adding ammonium fluoride thereto from time to time during the electrolysis. 8 claims.

- 1879 998,379. Process of electrolytic refining of zinc.—**Kunigoro Namekawa, Jishichiro Miyazama, Kumazo Miyabara, and Shotaro Emura**, Tokyo, Japan. Filed March 1, 1911. Issued July 18, 1911.

The process of electrolytically forming thick deposits of zinc from a zinc sulphate solution employing a plurality of lead anodes and suitable cathodes, which consists in adding to said solution a compound of vegetable origin which has been heated almost to the point of carbonization; in passing a current through said solution from said anodes to said cathodes; in passing a current at intervals from some of said anodes through the solution to certain other of said anodes to strip the latter of any lead sulphates that may have formed thereon; and in then passing a current from said last mentioned anodes to said first group of anodes to strip any sulphates from said first group of anodes. Patented also in England, no. 5,967 of 1911; in France, no. 430,167.

—Described in *Metallurgie*, vol. 9, p. 338. May 22, 1912.

- 1880 999,568. Electrolyte and method of depositing zinc.—**Edward Kern**, Knoxville, Tenn., assignor of one-half to Percy S. Brown, New York, N. Y. Filed Dec. 18, 1909. Issued Aug. 1, 1911.

A process of electrodepositing zinc, which consists in electrolyzing a solution containing chloride of zinc, chloride of ammonium, another metallic chloride and grape sugar. 21 claims.

- 1881 999,655. Electrolyte for depositing zinc.—**Edward F. Kern**, New York, N. Y., assignor of one-half to Percy S. Brown, New York, N. Y. Filed Oct. 11, 1910. Issued Aug. 1, 1911.

An electrolyte comprising chloride of zinc, and a double chloride of aluminum and another metal. 9 claims.

- 1882 1,006,330. Obtaining zinc and/or copper from complex ores or the like.—**John R. Williams, Henry W. Bradley and Benjamin Bradley**, Sheffield, England. Filed Aug. 9, 1909. Issued Oct. 17, 1911.

A process for the extraction of zinc, copper, or both including leaching the ore with dilute solution of sulphuric acid until the acid is exhausted, reacidifying the solution to substantially its initial concentration and repeating the operations until a solution containing a substantial quantity of metallic sulphate is formed, electrolyzing the solution removing therefrom sufficient metal to produce a solution of the initial acidity and employing this for further leaching. Patented also in England, no. 26,711 of 1908.

—Described in *Met. & Chem. Eng.*, vol. 9, p. 662. Dec., 1911.

- 1883 1,017,981. Electroplating with zinc.—**Auguste Arsene Le-metre**, Paris. Filed May 29, 1911. Issued Feb. 20, 1912.

A process of electroplating with zinc which comprises preparing a bath comprising zinc sulphate, water, and materials capable of producing ammonium chloride, sodium sulphate and sulphuric acid in the bath, and passing an electric current through said bath, containing an article to be electroplated, thus forming an adherent deposit of zinc upon such article.

- 1884 1,052,256. Electrolysis of metal salt solutions.—**Noak Victor Hybinette**, Kristiansand, Norway. Filed Jan. 5, 1912. Issued Feb. 4, 1913.

Diaphragms for use in the electrolytic deposition of metals from aqueous metal salt solutions, comprising a fibrous filtering material supported by a structure having leaden parts exposed to the action of the electrolyte. Patented also in France, no. 438,846.

- 1885 1,055,157. Electrolytic recovery of zinc and manganese.—**Andrew Gordon French**, Nelson, British Columbia, Canada. Filed Sept. 4, 1912. Issued March 4, 1913.

A process for the recovery of pure metallic zinc and manganese dioxide, said process comprising the passage of an electric current of from two and a half to four and a half volts from a lead anode to a zinc cathode immersed in a solution containing sulphate of zinc, sulphate of magnesium and neutral sulphate of sodium.... The electrolyte after being acted upon being continuously delivered to the leaching tank from which the original supply was obtained and continually replaced in the electrolytic tank by a supply drawn from the same leaching tank.

—Described in *Met. & Chem. Eng.*, vol. 11, p. 293. May, 1913.

- 1886 1,055,158. Electrolytic recovery of zinc and manganese.—**Andrew Gordon French**, Nelson, British Columbia, Canada. Filed Sept. 4, 1912. Issued March 4, 1913.

A process for the recovery of pure metallic zinc and manganese dioxide which comprises the electrolytic decomposition of a solution containing sulphate of zinc, sulphate of manganese and neutral sulphate of sodium, the electrolyte after being acted upon being treated to effect the regeneration of the required sulphate of manganese by treating dioxide of manganese in suspension by sulphurous acid gas or a sulphurous acid solution, and then delivering the electrolyte after being regenerated to the leaching tank from which the original supply was obtained and replaced in the electrolytic tank by a supply drawn from the same leaching tank. See also items 1780 to 1796.

—Described in Met. & Chem. Eng., vol. 11, p. 293. May, 1913.

- 1887** 1,059,233. Electrodeposition and refining of zinc.—**Uryln Tainton**, Manchester, and **John N. Pring**, Sandbach, England. Filed March 16, 1912. Issued April 15, 1913.

The herein described process for the electrolytic deposition of metallic zinc which consists in forming a solution of zinc and adding to the solution from 10 to 30 per cent of acid and a small proportion of gum tragacanth and electrolyzing the solution with a current of high density. 12 claims. Patented also in England no. 7,235 of 1911. See also item 1809.

- 1888** 1,107,309. Process for the electrolysis and treatment of sulphate liquors.—**Edwin James Hunt**, Oldbury, and **William Thomas Gidden**, Warley, England, assignors to Chance and Hunt, Ltd. Filed March 21, 1914. Issued Aug. 18, 1914.

In the process for the electrolysis of a zinc sulphate solution containing free sulphuric acid by the aid of a lead anode so conducting the process that the free particles of undissolved lead compounds derived from the anode cannot pass to the cathode while the electrolyte at both anode and cathode remains the same.

- 1888a** 1,089,412. Treatment of refractory zinc ores.—**P. C. C. Isherwood**, Bushey Heath, England. Filed Oct. 18, 1912. Issued March 10, 1914.

See item 586; also item 1717.

- 1889** 1,111,201. Process of extracting zinc from its ores or compounds.—**Ernest E. Watts**, Kingston, Ontario, Canada. Filed Nov. 20, 1913. Issued Sept. 22, 1914.

A process of extracting zinc which comprises mixing a material containing a high percentage of zinc in a non-elemental condition with a solution of zinc sulphate relatively free from dissolved iron compounds, in proportions to form thin paste, charging said paste into the anode compartment of an electrolytic cell containing an electrolyte consisting of a highly concentrated solution of zinc sulphate, said solution being relatively free from iron compounds, and then passing a suitable electric current through said cell, whereby the zinc is deposited at the cathodes.

- 1889a** 1,148,798. Electrolytic refining or extracting process.—**Francis R. Pyne**, Elizabeth, N. J., and **Henry M. Green**, Chrome, N. J., assignors to U. S. Metals Refining Co. Filed Apr. 20, 1915. Issued Aug. 3, 1915.

In an electrolytic refining or extracting process wherein the electrolyte contains more than one constituent, allowing stratification to take place to a determined or desired degree, and leading off portions of the electrolyte separately from different strata. 11 claims. See also item 1720.

- 1889b** 1,154,601. Extraction, purification, and electrolytic precipitation of metallic zinc from smelter fumes, zinc ores and

the like.—**Otto Best**, San Francisco. Filed Sept. 16, 1911.
Issued Sept. 28, 1915.

See item 401; also items 594 and 1702.

- 1890 1,163,286. Process of recovering zinc from an acid sulphite solution.—**Charles S. Vadner**, Salt Lake City, Utah. Filed May 26, 1914. Issued Dec. 7, 1915.

The process of recovering zinc from an acid sulphite solution which consists in electrolyzing the solution, partially neutralizing the acid that may be formed, and continuously electrolyzing for the recovery of the zinc and elimination of the SO_2 gas.

—Described in Jour. Soc. Chem. Ind., vol. 35, p. 124. Jan. 31, 1916.

—Described in Min. & Sci. Press, vol. 112, p. 483. April 1, 1916.

- 1891 1,163,911. Electrolysis.—**Clarence A. Hall**, Mount Airy, Pa. Filed March 6, 1913. Issued Dec. 14, 1915.

The process of maintaining the free anion concentration of a zinc electrolyte constant during electrolysis which consists in carrying on electrolysis in the presence of a finely divided substance which is insoluble in the absence of the current and which in the presence of the current combines with the liberated anions, forming a compound electrically inert in the electrolyte, and continually and thoroughly agitating the finely divided substance and electrolyte during electrolysis. See also items 1653 and 1712.

—Described in Jour. Soc. Chem. Ind., vol. 35, p. 186. Feb. 15, 1916.

- 1892 1,167,594. Electrolytic cell.—**Lewis E. Porter**, Los Angeles. Filed May 11, 1914. Issued Jan. 11, 1916.

See also item 1654.

- 1893 1,167,700. Process of extracting zinc from its ores.—**Frederick Laist** and **Frederick F. Frick**, Anaconda, Mont. Filed Aug. 13, 1915. Issued Jan. 11, 1916.

A cyclical process of extracting zinc from oxidized ores thereof containing iron, which consists in leaching the ore with dilute sulphuric acid, oxidizing the ferrous sulphate by means of a manganese compound in a state of oxidation higher than the manganous state, precipitating the ferric iron, electrolytically depositing the zinc from the purified solution with insoluble anodes, and utilizing the resulting acid solution containing manganese in its higher states of oxidation for the extraction of zinc from additional portions of the ore. 6 claims.

—Described in Jour. Soc. Chem. Ind., vol. 13, p. 314. March 15, 1916.

—Described in Met. and Chem. Eng., vol. 14, p. 220. Feb. 15, 1916.

- 1894 1,167,701. Process of recovering zinc from its ores.—**Fredrick Laist and Frederick F. Frick**, Anaconda, Mont. Filed Sept. 9, 1915. Issued Jan. 11, 1916.

A cyclical process of recovering zinc from oxidized ores there-of containing iron, which consists in leaching the ore with an acid reagent oxidizing the dissolved ferrous salt, purifying the solution by adding thereto an excess of calcine in presence of an agent capable of oxidizing ferrous iron, and electrolytically regenerating the oxidizing agent with simultaneous deposition of metallic zinc.

—Described in Jour. Soc. Chem. Ind., vol. 13, p. 314. March 15, 1916.

—Described in Met. & Chem. Eng, vol. 14, p. 220. Feb. 15, 1916.

- 1895 1,171,255. Treatment of ores.—**Otto Carl Rudolph**, Aldwych, London, England, assignor to Otto Stalmann, Salt Lake City, Utah. Filed Dec. 16, 1914. Issued Feb. 8, 1916.

A process for the treatment of complex ores containing volatile metals such as zinc, lead, and silver in combination with sulphur, consisting in fusing the ore charge and partially volatilizing its metallic constituents by electrical means, blowing air under pressure through the liquid charge to volatilize the remaining part of its volatile metallic constituents, dissolving the volatile zinc constituent and precipitating the volatile lead constituent given off during the fusing and blowing operations by a liquid, removing the precipitated lead from said liquid and finally recovering the metallic zinc by electrolytic treatment. 6 claims. Patented also in England, no. 29,156 of 1913.

- 1896 1,176,467. Process of treating zinc ores.—**Court C. Titus and William J. Barescheer**, Helena, Mont., assignors to New England Electro-Chemical Metals Company, Boston, Mass. Filed Aug. 31, 1914. Issued Feb. 29, 1916.

In a cyclical process of treating complex ores containing zinc, the steps which consist in chloridizing the dry ore in presence of sodium chloride, extracting the soluble chlorides, precipitating the metal contents of the solution with ultimate replacement of their chlorides by sodium chloride, electrolyzing the resulting sodium chloride solution, applying the evolved chlorine to the treatment of ore entering the cycle, and applying the chlorinated anode-liquor as a solvent for the chlorides derived from said ore. 10 claims.

- 1897 1,200,025. Process of recovering metals.—**Charles J. Reed**, Glenside, Pa. Filed Aug. 25, 1915. Issued Oct. 3, 1916.

The process of recovering zinc from its aqueous solutions which consists in electro-depositing the metal in a cathode of mercury, dissolving the zinc from the resulting amalgam and simultaneously depositing it on a cathode with which it does not alloy or amalgamate, and compensating the solution of metal by local action from the amalgam anode by supplying thereto the requisite additional quantities of amalgam.

—Described in Jour. Soc. Chem. Ind., vol. 35, p. 1223. Dec. 15, 1916.

- 1898 1,210,017. Electrolytic recovery of zinc from ores and other zinc-bearing materials.—**Urlyn C. Tainton**, Johannesburg, Transvaal, South Africa. Filed Aug. 10, 1915. Issued Dec. 26, 1916.

A continuous process for the electrolytic extraction of metallic zinc from a zinc-bearing material which consists in adding sufficient of the zinc-bearing material to an acid to make a neutral solution, separating the neutral solution from the residue, adding an excess of acid, and electrolyzing said solution by means of a current of high density and thus removing part of the zinc; then removing the solution now highly acid and dividing it into two portions, neutralizing one portion by a further addition of zinc-bearing material, adding a slight excess of zinc-bearing material to the neutral solution to remove any iron or other impurities present, separating the neutral solution from the residue, adding the other portion of the removed solution, and electrolyzing the acid solution so formed; and thereafter repeating the regenerating and electrolyzing process as described. 9 claims. Patented also in England, no. 11,335 of 1916; in France, no. 479,702. See also item 1811.

—Described in Jour. Soc. Chem. Ind., vol. 36, p. 145. Feb. 15, 1917.

- 1899 1,235,723. Apparatus for the production of zinc, copper or other metals by electrolysis.—**Marcel Perreux-Lloyd**, Boulogne-sur-Seine, France. Filed May 24, 1915. Issued August 7, 1917.

Apparatus for the production of metals by electrolysis, comprising a tank and a rotary cathode, a shaft on which said cathode is mounted, and means for supporting said cathode shaft, said means comprising a bracket adapted to be attached to the side of the tank, having a stuffing box in the wall of the tank for preventing liquid passing out around such shaft, and having outside of said tank beyond said stuffing box a bearing adapted to support said shaft. 6 claims.

- 1900 1,235,724. Apparatus for the electrolytic production of zinc, copper, or other metals.—**Marcel Perreux-Lloyd**, Boulogne-sur-Seine, France. Filed Dec. 14, 1915. Issued Aug. 7, 1917.

Apparatus for the production of metals by electrolysis comprising a rectangular vessel of small depth in which are mounted a plurality of rotary cathode mandrels of small diameter and of great length, each surrounded by a perforated lead anode, in the form of an open-topped trough, all the anodes being riveted or connected together and resting on supports disposed in the vessel, wiping impregnating pads of insolubilized animal substance being arranged to travel with an irregular reciprocating motion over the surface of the metal deposited on the cathode cylinders. 7 claims. See also item 1657.

- 1901** 1,241,966. Zinc-extraction process.—**Herbert R. Hanley**, Winthrop, Cal., assignor to Bully Hill Copper Mining and Smelting Company. Filed June 5, 1916. Issued Oct. 2, 1917.

The process of extracting zinc from zinc bearing material containing arsenic, antimony, selenium, tellurium, bismuth or the like, which consists in treating said materials with sulphuric acid, roasting at a temperature at which the zinc compounds are converted to zinc sulphate and arsenic, selenium and the like are volatilized, leaching the product with water to dissolve soluble constituents, electrolyzing the solution to largely decompose the zinc sulphate, forming zinc and sulphuric acid, concentrating the spent liquor, and utilizing the same for roasting with fresh quantities of zinc bearing material. 11 claims.

—Described with abstract in *Met. & Chem. Eng.*, vol 18, p. 485, May 1, 1918.

- 1902** 1,241,967. Electrolytic apparatus.—**Herbert R. Hanley**, Winthrop, Cal., assignor to Bully Hill Copper Mining & Smelting Company. Filed June 5, 1916. Issued Oct. 2, 1917.

An aerating device comprising a receptacle containing a liquid, an air supply pipe, one or more pipes communicating therewith through a non-submerged orifice, said pipes having a submerged orifice of larger diameter than the said non-submerged orifice.

—Described with diag., in *Met. Chem. Eng.*, vol. 18, p. 485. May 1, 1918.

- 1903** 1,247,179. Electrodeposition and extraction of zinc.—**Urlyn Clifton Tainton**, London, and **John Norman Pring**, Chester, England. Filed Nov. 7, 1916. Issued Nov. 20, 1917.

A continuous process for the electrolytic extraction of metallic zinc from a zinc-bearing material, which consists in adding sufficient of the zinc-bearing material to an acid to make a neutral solution free from any colloid agent, separating the neutral solution from the residue, adding an excess of acid, electrolyzing said solution by means of a current of high density and thus removing part of the zinc, then removing the solution now strongly acid, and dividing it into two portions, neutralizing one portion by further additions of zinc-bearing material, separating the neutral solution from the residue, adding the other portion of the removed solution and electrolyzing the acid solution so formed, and thereafter repeating the regenerating and electrolyzing process as described.

—Described in *Met. & Chem. Eng.*, vol. 18, p. 486. May 1, 1918.

- 1904** 1,251,302. Electrolytic recovery of metals from their solutions.—**Urlyn Clifton Tainton**, Johannesburg, Transvaal, South Africa. Filed July 6, 1915. Issued Dec. 25, 1917.

The process of precipitating metals from solutions which consists in introducing the solution into an electrolytic cell, producing therein a rapid relative movement between the cathode and the

solution whereby the metal precipitated on the cathode is detached therefrom and removing the precipitated metal from the cell. 6 claims.

- 1905** 1,255,435. Method of purifying zinc-bearing solutions.—**Frederick Laist** and **James Orr Elton**, Anaconda, Mont., assignors to Anaconda Copper Mining Company. Filed June 16, 1916. Issued Feb. 5, 1918.

In a process of purifying zinc-bearing solutions the step which consists in subjecting the impure solutions to the action of electrolytically deposited zinc sponge. 4 claims.

- 1906** 1,255,436. Process of recovering zinc from ores.—**Frederick Laist** and **James Orr Elton**, Anaconda, Mont., assignors to Anaconda Copper Mining Company. Filed June 16, 1916. Issued Feb. 5, 1918.

A cyclical process of recovering zinc from ores thereof containing arsenic or antimony, consisting in alternately leaching the ore with an acid solvent for zinc, and electrolytically precipitating zinc from the resulting solution, introducing iron into the solution subsequent to the electrolysis from an outside source and in proportion sufficient for the substantial elimination of arsenic and antimony, and removing the iron therefrom, together with the arsenic and antimony, by precipitation in the ferric state prior to the succeeding electrolysis. 5 claims.

—Described in Min. & Sci. Press, vol. 116, p. 824. June 15, 1918.

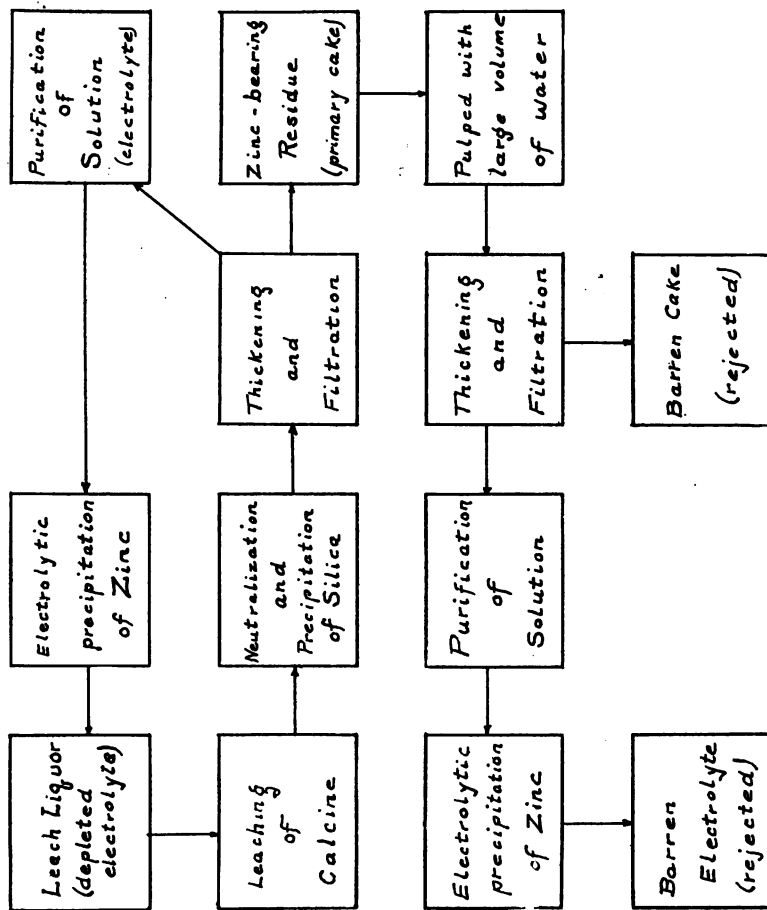
- 1907** 1,255,437. Electrodeposition of metals.—**Frederick Laist** and **James Orr Elton**, Anaconda, Mont., assignors to Anaconda Copper Mining Company. Filed June 16, 1916. Issued Feb. 5, 1918.

In the deposition of metals by electrolysis, the combination with a purifying system, a storage system, and a main electrolytic system, of an indicator cell in the line of flow of the solution between the purifying and storage systems. 2 claims.

- 1908** 1,255,438. Process of treating zinc ores.—**Frederick Laist**, Anaconda, Mont., assignor to Anaconda Copper Mining Company. Filed July 10, 1916. Issued Feb. 5, 1918.

The process of treating zinc ores containing iron, which consists in calcining the ore, leaching the calcine with a solution containing sulphuric acid, precipitating the iron from the resulting solution by a material containing zinc oxide, separating the precipitate from the iron-free solution, furnacing said precipitate at a temperature materially below that of the calcination, said temperature sufficient to render the ferric compounds insoluble, while avoiding substantial decomposition of zinc sulphate, and extracting the zinc sulphate from the furnaced product. 2 claims.

- 1909** 1,255,439. Process of recovering zinc from ores.—**Frederick Laist** and **James Orr Elton**, Anaconda, Mont., assignors



FLOW SHEET OF LAIST'S (ANACONDA) PROCESS OF TREATING SILICIOUS CALCINES
(See item 1913a)

to Anaconda Copper Mining Company. Filed July 10, 1916. Issued Feb. 5, 1918.

The process of recovering zinc from its ores, which consists in leaching the ore with an acid solvent for zinc, precipitating iron as a ferric compound, treating the resulting solution with finely divided zinc to precipitate metals electronegative thereto, electrodepositing zinc in sponge form from portions of the treated solution, thereby further purifying such portions of the solution and preparing finely divided zinc for use in the precipitating stage of the operation, depositing further quantities of zinc as a reguline metal and re-using the resulting acid solution in the leaching process. 3 claims.

—Described in Met. & Chem. Eng., vol. 18, p. 549-50. May 15, 1918.

1910 1,255,440. Process of treating complex ores or concentrates therefrom.—**Frederick Laist**, Anaconda, Mont., assignor to Anaconda Copper Mining Company. Filed Nov. 3, 1916. Issued Feb. 5, 1918.

The process of recovering zinc, lead, copper and the precious metals from ores or concentrates containing the same, which consists in leaching the roasted ore with dilute sulphuric acid, separating and purifying the resulting zinc-bearing solution and recovering the zinc therefrom by electrolysis; smelting the residue containing the copper, the lead and the precious metals and some zinc, and thereby producing a matte containing the copper and precious metals and a fume consisting largely of oxides of lead and zinc; extracting the zinc from the fume by dilute sulphuric acid, leaving a residue high in lead; and recovering copper and the precious metals from the matte.

—Described in Min. & Sci. Press, vol. 116, p. 824. June 15, 1918.

1911 1,259,594. Treatment of zinc-bearing material containing iron.—**Anson G. Betts**, Ashville, N. C. Filed April 21, 1916. Issued March 19, 1918.

The process of treating oxidized zinc-bearing material containing iron, comprising leaching the material with an acid solution to dissolve out the greater portion of the zinc with a minimum of iron; leaching the residue with an acid solution for extraction of the remaining zinc, whereby more or less iron is also extracted and electrolytically recovering zinc from both solutions separately. 7 claims.

1912 1,262,190. Treatment of zinciferous ores.—**James H. Gillies** and **Percy M. Gillies**, East Camberwell, Victoria, Australia. Filed Jan. 22, 1917. Issued April 19, 1918.

In the treatment of complex sulphide ores of the kind indicated, fuming the zinc and the lead from the crushed and semi-roasted ore in a furnace, retreating the clinker with fluxes to recover precious metals and copper, and fuming off any remaining zinc, treating the zinc and lead fume with sulphuric acid solution to dissolve the zinc oxide and the resulting zinc sulphate solution with hydrogen sulphide gas to precipitate arsenical and like im-

purities and electrolyzing the purified solution to deposit metallic zinc.

- 1913 1,263,852. Method of purifying zinc-sulphate solutions.—**Russell B. Caples**, Great Falls, and **Frederick F. Frick**, Anaconda, Mont., assignors to Anaconda Copper Mining Company. Filed Sept. 4, 1917. Issued April 23, 1918.

In the purification of zinc sulphate solutions, the steps which consist in preparing a solution containing at least one part by weight of copper for each part by weight of arsenic and antimony to be eliminated, calculated as trioxides, and subjecting the said solution at a temperature of about 80° C. to the action of metallic zinc, whereby arsenic and antimony are precipitated in association with copper.

- 1913a 1,281,032. Process of recovering zinc.—**Frederick Laist**, Anaconda, Mont., assignor to Anaconda Copper Mining Company. Filed Jan. 29, 1918. Issued Oct. 8, 1918.

In a process of recovering zinc from a silicious calcine, the steps which comprise leaching the calcine with an acid liquor, neutralizing the liquor and thereby precipitating silica in presence of the insoluble residue, separating the zinc bearing solution from the residue, re-pulping the residue with water and separating the resulting dilute zinc-bearing solution therefrom, and separately recovering zinc from the two zinc-bearing solutions by electrolyzing said solutions with insoluble anodes. See also item 608a.

- 1913b 1,283,077. Electrolytic production of zinc.—**Galen Howell Clevenger**, Palo Alto, Cal., assignor to Herbert W. Gepp, Melbourne, Victoria, Australia. Filed May 7, 1917. Issued October 29, 1918.

In the electro-deposition of zinc, the method of removing cobalt from zinc sulphate electrolytes containing manganese, which comprises neutralizing the electrolyte and then precipitating the cobalt by means of an oxidizing agent. 10 claims.

- 1913c 1,283,078. Electrolytic recovery of zinc.—**Galen Howell Clevenger**, Palo Alto, Cal., assignor to Herbert W. Gepp, Melbourne, Victoria, Australia. Filed May 7, 1917. Issued October 29, 1918.

In the electro-deposition of zinc, the method of removing cobalt from the electrolyte, which comprises precipitating the cobalt with nitroso-beta-naphthol by effecting the formation of nitroso-beta-naphthol within the electrolyte and precipitating the cobalt therewith. 10 claims. Patented also in England, No 115,847 of 1918.

Great Britain

- 1914 12,249 of 1886. Electrolytically obtaining metallic zinc from alkaline solutions of zinc oxide.—**W. S. Squire** and **S. C. C. Currie**, London.

"The solution is electrolyzed with an anode of iron or carbon and a cathode of mercury. The resulting amalgam is distilled to separate the mercury."

- 1915 12,630 of 1886. Obtaining metallic zinc from its ores.—**W. S. Squires** and **S. C. C. Currie**, London.

"The ore is dressed, obtained as oxide by roasting, dissolved in potassium or sodium hydroxide, and electrolyzed with a mercury cathode." Modification of 12,249, above.

- 1916 6,294 of 1887. Improvements in the electrolytic treatment of zinc and its ores.—**A. Watt**, London.

Uses as electrolyte a "dilute vegetable acid, preferably commercial acetic acid, or a solution of zinc or its ores in such a liquid. The anodes may be masses of impure zinc or may be of carbon or other insoluble material. The cathodes may be of carbon, greased or dirty metal, or thin sheets of good zinc. An excess of metallic impurities in the solution may be precipitated by sulphuretted hydrogen."—**J. S. C. I.**

- 1917 9,886 of 1888. Improvements in the reduction of zinc oxides.—**C. A. Burghardt**, Manchester, England.

Electrolyzes an alkaline zincate solution with pure zinc cathodes.

- 1918 17,205 of 1889. Improvements in the process of obtaining zinc by electrolysis.—**A. S. Elmore**, Rothwell, England.

Porous cells are placed in a bath of zinc sulphate. The anode is of iron. The cathode is a disc or cylinder which revolves, and as the zinc is deposited upon it, it is acted on by a burnisher, which makes the deposited metal compact and close in texture.

- 1919 8,716 of 1890. New or improved process for obtaining, by electrical decomposition, metallic zinc from solution of sulphite of zinc.—**E. Edwards**, London.

"Sulphite is used instead of sulphate as electrolyte, as the difficulty of keeping the bath neutral is thereby obviated and the metal obtained of better quality."

- 1920 2,225 of 1892. Improvements in the method of purifying electrolytes containing zinc, relating to or connected with the electrometallurgy of zinc.—**G. Nahnsen**, Cologne, Germany.

Zinc powder is used. "When the impurities consist of copper only the amount of 1%, 10 lbs. of copper must be precipitated by means of zinc powder in the daily production of 1000 lbs. of zinc, which will necessitate a daily addition of 11 lbs. of zinc."

- 1921 2,913 of 1892. Improvements in the electrometallurgic extraction of zinc.—**G. Nahnsen**, Cologne, Germany.

"Uses an electrolyte composed of a mixture of the sulphate of zinc with a sulphate of the alkalies, but preferably not magnesia, and heating the bath to a temperature of about 130° F." Claims higher conductivity than zinc sulphate electrolyte, and wide range of current density is possible.

- 1922 16,892 of 1892. Process and apparatus for the extraction, separation, and refining of metals by electrolysis.—**D. Tommasi**, Paris.

- 1923 13,336 of 1893. Electrolytic recovery of nickel, zinc or other metals.—**Carl Hoepfner**.
- 1924 17,446 of 1893. Production of zinc by electrolysis.—**W. Wright**, Bettws-y-coed, and **J. B. Hammond**, Bromley.
Pressing the spongy zinc into thin sheets before melting, so that no oxide is produced in melting.
- 1925 5,537 of 1894. Electrolytic precipitation of zinc and alloys of zinc, and apparatus therefor.—**R. Heathfield** and **W. S. Rawson**, London.
Deposition on iron, steel, or other metallic articles, which are first electrolytically coated with mercury, and then treated electrolytically in a zinc-salt solution.
- 1926 7,145 of 1894. Improvements in or connected with the electrodeposition of zinc or zinc compounds, and the treatment of the deposited metal or compounds.—**S. O. Cowper-Coles** and **B. W. Walker**, London.
Claims use of an alkaline electrolyte in which zinc or a zinc compound, finely divided, is suspended; also the alternation of brief currents of high density with longer currents of lower density, to brighten the deposited metal; also the use of a sort of sand blast to brighten the metal after deposition.
- 1927 8,085 of 1894. Improvements in the art of producing metallic zinc.—**P. C. Choate**, New York.
"Zinc is volatilized as fume... This fume is reheated with carbon at moderate temperature so as to eliminate any metallic constituents which are more volatile than zinc. It is finally reduced, distilled, and cast into anodes. These anodes are immersed in a zinc sulphate solution containing a little soluble chloride... On passing a current of electricity, pure zinc is deposited."—**J. S. C. I.**
- 1928 22,826 of 1894. Preparation of zinc solutions for electrolysis.—**J. Brock**, **A. E. Waring** and **F. Hurter**, Liverpool, England.
"Zinc chloride solutions which have been obtained by roasting ore and dissolving the roasted product in HCl, may be freed of sulphuric acid by adding calcium, barium, or strontium chloride, and filtering."—**Zeits. f. Elektrochem.**
- 1929 22,827 of 1894. Preparation of zinc solutions for electrolysis.—**J. Brock**, **A. E. Waring** and **F. Hurter**, Liverpool, England.
If the solution contains oxides of other metals, zinc oxide is added at high temperature, thus precipitating the metals detrimental to electrolysis.
- 1930 22,828 of 1894. Utilization of zinc blende for obtaining metallic zinc and sulphur, effecting the decomposition of common salt for the production of soda and chlorine.—**J. Brock**, **A. E. Waring** and **F. Hurter**, Liverpool, England.

Zinc blende is roasted to obtain zinc oxide and sulphurous acid, and from the latter sulphuric acid is obtained. The zinc oxide is converted into zinc chloride and electrolyzed.

- 1931 24,861 of 1894. Improvements in the treatment of sulphide ores containing zinc in association with other metals.—**T. Parker**, Wolverhampton, England.

Treatment of zinc-lead sulphides by dissolving in hydrochloric or sulphuric acid, electrolyzing the solution for zinc, and recovering the acid, and treating the residues for silver and lead.

- 1932 584 of 1895. Improved method and apparatus for obtaining chlorine and zinc in the treatment of ores containing zinc or blende and other metals or metalloids.—**H. R. Lewis**, London, and **C. Gelstharp**, Manchester.

—Described in Jour., Soc. Chem. Ind., vol. 15, p. 119. Feb. 29, 1896.

- 1933 2,999 of 1895. Improvements in and means to be employed for the obtaining of zinc from its ores, and electrolytic deposition of zinc upon iron or other metal or alloys.—**S. O. Cowper-Coles**, London.

"Bright, non-spongy deposits are obtained from the following electrolyte: a gallon of water, 35 ounces zinc sulphate, 12 ounces iron (preferably ferric) sulphate. The electrolytic oxygen, liberated when the zinc is deposited, prevents the formation of hydrogen compounds of zinc, and consequently of spongy zinc.

- 1934 4,154 of 1895. Improvements in apparatus for use in electrolysis.—**S. O. Cowper-Coles**, London.

"The anodes and the articles to be coated make contact with conducting cross- or bridge-pieces, 'girders,' superposed but insulated from each other. The object is to bring the anodes and the articles to be coated into close proximity in a simple and convenient manner."—J. S. C. I.

- 1935 8,449 of 1895. Leaching and electrolytic recovery of zinc.—**C. Hoepfner**. April 29, 1895.

"Roasts and dissolves zinc oxide with H_2SO_4 , neutralizes excess of acid, decomposes $ZnSO_4$ with $CaCl_2$, obtaining $ZnCl_2$ in solution, and $CaSO_3$ precipitated; the latter is soluble in H_2SO_4 and is available for wood-pulp manufacture. Zinc is precipitated by electrolysis from the chloride solution." Mineral Industry, 1896.

- 1936 13,434 of 1895. Electrolytic deposition of zinc.—**Siemens** and **Halske**, Berlin.

Keeps up a vigorous circulation of the electrolyte by means of jets of compressed air, so as to prevent the formation of spongy zinc.

- 1937 13,534 of 1895. Electrolytic treatment of refractory zinc-lead ores.—**E. A. Ashcroft**, Broken Hill, New South Wales.

Modifications of patentee's process. See also 7532 of 1897, below.

- 1938 14,783 of 1895. Improved process for the treatment of metalliferous ores and products.—**E. A. Ashcroft**, Grays, England.

An improvement on 13,534, above. Employs anodes composed of iron or copper mattes.

- 1939 17,745 of 1895. Improvements in electrolytic or galvanic processes or cells.—**C. Hoepfner**, Giessen, Germany, and **H. H. Lake**, London.

"To allow the use of as low an E. M. F. as possible, soluble anodes are employed." These may consist of lead or similar metals, but not of zinc or iron.

- 1940 19,934 of 1895. Process and apparatus for the electrolytic production of metallic zinc and metallic copper from zinc ores containing copper, obtaining oxygen gas as a by-product.—**C. A. Burghardt**, Manchester, and **G. Rigg**, Eccles, England.

—Described in *Mineral Industry*, vol. 5, p. 602. 1896.

- 1941 22,732 of 1895. Improvements in a process and apparatus for the electrolytic production of metallic zinc from ores of zinc, and the production of oxygen gas.—**C. A. Burghardt**, Manchester, and **G. Rigg**, Eccles, England.

Modification of 19,934, above.

- 1942 23,543 of 1895. Improved process for treating sulphide ores containing zinc and other metals.—**T. Parker**, Wolverhampton, England.

Treats zinc ores with hot hydrochloric acid and keeps the solution neutral with carbonate of zinc, then electrolyzes to produce zinc and chlorine.

- 1943 25,002 of 1895. Improvements in electrolytic apparatus.—**R. Heathfield** and **W. S. Rawson**, London.

Rotating deposition barrel with Portland cement staves.

- 1944 1,575 of 1896. Process for the electrolytic extraction of zinc from its ores.—**Siemens** and **Halske**, Berlin.

"Zinc oxide is dissolved in neutral aluminum sulphate, electrolyzed between insoluble anodes at 3 volts pressure, whereby zinc is deposited at the cathode, and oxygen at the anode, while the basic aluminum sulphate is reconverted to neutral sulphate for subsequent use. The bath is best prepared by dissolving the ZnO in a warm 10 to 15% solution of neutral aluminum sulphate."—*Mineral Industry*, 1896.

- 1945 4,432 of 1896. Process for the recovery of zinc from blende ores.—**The Exploring and Gold Mining Association, Ltd.**, and **S. H. Emmons**, California.

The roasted ore is placed in a series of vats arranged in cascade form, each slightly lower than that preceding it. The alternate

vats are connected with an electrolyzing current. Water flowing over the ore in vat no. 1 extracts zinc sulphate, which is electrolyzed in vat no. 2. The sulphuric acid liberated is neutralized by the zinc oxide in vat no. 3, and is ready to be electrolyzed again in vat no. 4, and so on. See also item 1708.

- 1946 11,074 of 1896. Method of producing zinc by electrolysis.—**E. A. Ashcroft**, Melbourne, Victoria.

- 1947 11,076 of 1896. Improvements in the treatment of ores containing zinc.—**E. A. Ashcroft**, Melbourne, Victoria.

"This process was devised to enable zinc blende (alone or mixed with galena) to be so treated as to yield directly an electrolyte from which the zinc may be deposited electrolytically without formation of spongy deposits. This may be accomplished by having oxy salts of zinc in the solution from which the zinc is being separated."

—Described in Jour. Soc. Chem. Ind., vol. 16, p. 684, Aug. 31, 1897.

- 1948 13,169 of 1896. Treatment of sulphide ores for the separation of zinc from the lead and other metals.—**H. Mohr**, Hampstead.

"The pulverised ore is fused with acid sodium or potassium sulphate, and the fused mass is dissolved in hot water, a small quantity of sulphuric acid being added when necessary." Zinc is deposited by electrolysis.—**J. S. C. I.**

- 1949 17,608 of 1896. Improvements in means or apparatus for effecting the electro-deposition of zinc upon tubes or other circular or analogous objects.—**S. O. Cowper-Coles**, London.

- 1950 24,573 of 1896. Production of zinc chloride, or of zinc and chlorine.—**E. Hoepfner**, London.

—Described in Jour. Soc. Chem. Ind., vol. 16, p. 1015. Dec. 31, 1897.

- 1951 25,804 of 1896. Improvements in the electrolytic production of zinc and alkalies.—**Otto Dieffenbach**, Darmstadt.

- 1952 7,532 of 1897. Improvements in the combined electrolytic and leaching treatment of zinc bearing ores and zinc-bearing products.—**E. A. Ashcroft**, Newcastle, N. S. W.

An improvement on 13,534 of 1895 above. "Employs carbon instead of soluble iron anodes; and the solution of ferric sulphate or chloride employed in leaching the zinc ores is not prepared electrically, but is only regenerated in the anode compartments."

—Described in Jour. Soc. Chem. Ind., vol. 17, p. 253. March 31, 1898.

- 1953 4,296 of 1898. Improved process for the recovery of zinc from refractory zinc-bearing ores.—**J. Jones**, Melbourne, Australia.
Electrolysis of zinc sulphate and ammonium sulphate solution.
See also item 1710.
- 1954 5,943 of 1898. Improvements in the treatment of zinc-bearing ores for obtaining zinc and other metals therefrom.—**S. O. Cowper-Coles**, London.
—Described in *Jour. Soc. Chem. Ind.*, vol. 17, p. 1053, Nov. 30, 1898.
- 1955 22,710 of 1899. Apparatus for the electrolytic extraction of zinc.—**S. Stepanoff**, Petrograd, Russia.
A method of increasing the extraction of zinc electrolytically from the sulphate.
- 1956 24,135 of 1899. Process for extracting zinc from sulphide ores.—**James Gitsham**, Victoria, Australia.
"The pulverized ores are roasted at a temperature of about 600°F., with the addition of 1% of powdered metallic zinc; they are then leached, at first with water, afterwards with dilute sulphuric acid, aided by steam; finally the zinc is precipitated by an alkali."—**J. S. C. I.**
- 1957 9,563 of 1900. An electrolyzing process for zinc and other salts with insoluble anodes.—**Societe des Piles Electriques**, Paris.
Improved circulation of fluids in cells for electro-deposition of zinc.
—Described in *Jour. Soc. Chem. Ind.*, vol. 20, p. 484. May 31, 1901.
- 1958 17,612 of 1900. Treatment of sulphide ores.—**J. Swinburne** and **E. A. Ashcroft**, London.
Method of purifying the bath.
- 1959 22,699 of 1900. Electrolytic separation of metals.—**H. A. Frasch**, Hamilton, Ontario, Canada.
Improved electrolytes for use in electrolytic separation of metals.
- 1960 23,647 of 1900. Electrolytic deposition of metals.—**H. C. Harrison** and **J. Day**, London.
Apparatus for the rapid electro-deposition of metals with a current of high density and producing tough metal, the electrolyte being projected tangentially on the surface of deposit.
- 1961 1,849 of 1901. Electrolytic treatment of alkali metals.—**A. Brochet** and **G. Ranson**, Paris, France.
Electrolyzing sulphides of alkali earth metals in the presence of a chloride, thus producing hydrated oxides.

- 1962 9,731 of 1901. Electro-deposition of metals.—**S. O. Cowper-Coles**, London.

Improvements in inventor's system of electro-deposition on rapidly rotating mandrels, by projecting the electrolyte tangentially against the mandrels.

- 1963 15,128 of 1902. Electro-deposition of zinc.—**Columbus Electricity Company**, Ludwigshafen-on-Rhine, Germany.

In the electrodeposition of zinc on sheet metal, improved method for keeping the anode and cathode at equal distance and of reducing the distance in order to decrease the resistance.

- 1964 2, 574 of 1903. Electrolytic extraction of metals.—**Mechwart, Coltri & Co.**, Milan, Italy.

In an electrolytic cell for the extraction of metals from roasted sulphides, the use of a liquid diaphragm between the anode and cathode cells and the use of a heated anode.

- 1965 15,420 of 1903. Obtaining zinc by electrolysis.—**Karl Kaiser**, Berlin, Germany.

"The ore, after roasting and crushing, is treated with sufficient zinc chloride to agglomerate the mass, forming oxy-chloride of zinc. After drying, the mass is crushed and treated with hydrochloric acid preferably while hot. In a quarter of an hour the whole of the zinc present should have dissolved, with, however, but little of the iron contained in the mineral. Electrolysis is then effected with insoluble anodes and zinc, iron or other cathodes. The anodes may, with advantage, be made cylindrical and be rotated on their axes."—J. S. C. I.

- 1966 24,985 of 1906. Electrolytic refining.—**S. O. Cowper-Coles**, London.

"In the electrolytic refining of metals, the arrangement of three electrodes concentrically, the inner and outer being the cathode and the middle one the anode, and the whole rotated at a high speed."—E. & M. J.

- 1967 8,562 of 1907. Electro-deposition of zinc.—**H. Paweck**, Vienna.

"Zinc is deposited electrolytically from a bath containing one or more salts of the metal, with or without the addition of conductive salts or other substances. The liquid is maintained neutral, or preferably slightly acid, by intermittent and continuous regeneration... The latter is effected by addition of substances which yield hydrogen ions in aqueous solution. Boric or phosphoric acid or the like may also be added...."—J. S. C. I.

- 1968 24,631 of 1909. Process for utilizing spongy zinc obtained electrolytically.—**Eduardo Sanna**, Ingurtosu, Italy.

"The spongy zinc is washed in a solution of sodium nitrate, and then while still moist is heated to 100°-150°C. and simultaneously exposed to a pressure of about 1000 kilos per sq. cm. It is stated that dense metallic zinc is readily obtained in this way."—J. S. C. I. Patented also in France, no. 415,639; in Germany, no. 217,632.

—Described in Min. Mag., vol. 3, p. 58. July, 1910.

- 1969 1,341 of 1910. Recovery of metals in complex or low grade ores.—**S. Laszczynski**, Miedzianka, Poland and **W. Stoecker**, Vienna. Jan. 8, 1910.

Copper and zinc are deposited in separate operations.

—Described in Jour. Soc. Chem. Ind., vol. 30, p. 429-30. April 15, 1911.

- 1970 17,785 of 1910. Treatment of silicious zinc ores.—**F. B. Dick**, Hampton, Middlesex, England.

The finely divided ore is mixed with water, and sulphuric acid is added, not in excess, to convert zinc into sulphates. After evaporation, the mass is heated to render the hydrated silica insoluble but not to decompose the zinc sulphate. The residue is leached with water and electrolyzed for zinc.

- 1971 15,128 of 1911. Manufacture of manganese peroxide anodes.—**Siemens and Halske Akt.—Ges.**

- 1972 11,271 of 1912. Electro-deposition of zinc.—**E. Ballegeer**, Uccle-lez-Brussels, Belgium. May 11, 1912

"The article, after being cleaned, is dipped into a bath of water (100 litres), a zinc chloride solution of 46° Be. (40 litres), ammonium chloride (8 kilos), sodium chloride (2½ kilos), and tartaric acid (2½ kilos). An electric current is passed through the cold bath, using a pure zinc plate as anode, and employing a current density of 100 amp. per sq. m. of cathode surface."—J. S. C. I.

- 1973 4,861 of 1915. Apparatus for electrolytic production of zinc.—**M. Perreux-Lloyd**, Boulogne, France. Patented also in France, No. 472,764.

- 1974 9,957 of 1915. Preparation of electrolytes for use in the electric deposition of metals.—**P. Marino**, London.

"An electrolyte, for the electrodeposition of copper, zinc, lead, etc., is prepared by treating a solution of a salt, or oxide of the metal, with a suitable reagent, and then completely dissolving the precipitate in a suitable solvent. Ammonium, sodium, or potassium salicylate and ammonia are then added to the solution thus prepared."—J. S. C. I.

- 1975 10,133 of 1915. Process for electrolytic deposition on all metals of aluminum, tin, nickel, copper, zinc, iron, steel, or alloys thereof.—**P. Marino**, London.

"An electrolyte for plating is prepared by using one of the metals named as anode in a strong solution of $\text{Na}_2\text{P}_2\text{O}_7$ to which has been added H_3PO_4 , say 10%, and sulphanilic acid, say 5 to 15 %. A soluble anode is also used during plating."—Chem. Abst.

—Described in Jour. Soc. Chem. Ind., vol. 35, p. 54, Jan. 15, 1916.

- 1976 16,336 of 1915. Electrodeposition and extraction of zinc.—**U. C. Tainton**, London, and **J. N. Pring**, Chester.

"A strongly acid zinc solution, containing no colloid, is electrolyzed with high current density. The zinc deposited is firm.

though lacking in smoothness. 16% of H_2SO_4 may be added to a saturated solution of ZnSO_4 to form the electrolyte. A current density of 600 amp. per square foot may then be employed. The anodes may be of zinc, lead or lead oxide. The invention may be employed in the extraction of zinc from its ores, as by the cyclic process."—Chem. Abst.

—Described in Jour. Soc. Chem. Ind., vol. 36 p. 37. Jan. 15, 1917.

- 1977 4,681 of 1916. Apparatus for the electrolytic production of zinc.—**M. Lloyd-Perreux.**

—Described in Min. Jour., vol. 112, p. 156. March 4, 1916.

- 1978 100,739 of 1916. Electrolytic apparatus.—**Siemens and Halske, A.—G.,** Berlin.

The wires forming the electrodes are connected with and are hung freely from the same conductor and are weighted at their lower ends with a single piece, or with individual spherical, cylindrical or other weighting pieces; or the wires may be weighted at both ends and hung over the conductor or an insulator.

—Described in Jour. Soc. Chem. Ind., vol. 35, p. 931. Sept. 15, 1916.

- 1979 104,697 of 1916. Extraction of zinc.—**H. L. Sulman, H. F. K. Picard,** and **The Metals Extraction Corporation, Ltd.,** London.

Electrolysis of sulphate solution.

- 1980 105,255 of 1916. Electrolytic deposition of zinc on metallic surfaces.—**P. Marino,** London.

"The electrolyte consists of a concentrated aqueous solution of a zinc salt, to which 8 to 10% of glycerol-sulphuric acid, 8 to 10% of boric acid, and 5 to 10% of a halogen derivative of lactic acid has been added."—J. S. C. I.

- 1980a 105,830 of 1916. Electrolytic production of sulphides.—**C. O. Griffith.**

"Sulphides of zinc, antimony, iron, lead, copper, etc., are prepared by the use of electrodes both of the same metal, the cathode being coated wholly or in part with sulphur. A suitable electrolyte contains chloride of NH_4 or Na of the electrode metal, or a mixture. The temperature of the electrolyte may be 50° to 70° ."—Chem. Abst.

- 1980b 108,312. Refining metallic zinc-bearing materials by the electrolytic process.—**C. H. Aldrich** and **J. K. Bryan,** assignors to The Electrolytic Zinc Co., New York. Appl. No. 10,073 of 1917.

"Zinc-bearing minerals are refined electrolytically by use of an acid electrolyte containing from 0.1 to 0.5% of free acid, at about 40°C , or lower."

—Described in Jour. Soc. Chem. Ind., vol. 37, p. 518A. Sept. 16, 1918.

- 1981 112,336 of 1917. Treatment of zinciferous ores.—**J. H. and P. M. Gillies**, East Camberwell, Victoria. Feb. 1, 1912.

A purified zinc sulphate solution is electrolysed with zinc cathodes and lead anodes. To secure an even deposition, .5 to 1.0 gram of gum arabic may be added per litre of solution.

—Described in Jour. Soc. Chem. Ind., vol. 37, p. 94A-95A.

France

- 1982 358,622. New process for electrodeposition of zinc and its alloys.—**G. Langbein & Co.** Oct. 18, 1905.

"The process of electrodeposition of zinc upon metallic objects is improved by the addition of urea to the bath. Double salts which are readily soluble are formed, and a high current density can be maintained without resulting in the formation of a spongy deposit."—J. S. C. I.

- 1983 370,803. Electrolytic extraction of zinc from its ores.—**C. J. Tossizza.** Dec. 30, 1905.

"Salts of zinc are electrolyzed, using insoluble anodes, in a vat divided into two compartments by a porous diaphragm. The solution in the anode compartment is saturated with sulphurous acid to act as a polarizer, in order to permit electrolysis to be carried on with a low and constant voltage. Around the cathode is maintained a liquid charged with substances which will neutralize the free sulphuric acid produced at the anodes. Evolution of hydrogen at the cathode is thus avoided, and good deposits of zinc are obtained."—J. S. C. I. See also U. S. Patent 703,857.

- 1984 406,150. Process for the preparation of zinc compounds (oxide, etc.) by electrolysis.—**E. Leriche.** Dec. 1, 1908.

"Consists in electrolyzing, with a zinc anode and without a diaphragm, a solution containing a salt of a soluble base, the acid radical of which forms a soluble salt with zinc..."

—Described in Jour. Soc. Chem. Ind., vol. 29, p. 425. April 15, 1910.

- 1985 415,639. Extraction of lead and zinc from mixed ores.—**Edoardo Sanna**, Ingurtoosu, Italy. May 6, 1910.

The ore is treated with a boiling solution of caustic soda and electrolyzed in an iron vessel. The lead is separated in a spongy condition. The residual solution is again electrolyzed in a zinc vat. A coherent deposit is obtained by the means described in English Patent 24,631 of 1909.

- 1986 476,346. Cyclic process for the treatment of complex, man-ganiferous ores of zinc and lead.—**A. G. French.** Oct. 20, 1914.

The ore is roasted at a low temperature (About 700° C.) until evolution of sulphur dioxide ceases, then mixed with 4 to 5% of sodium bisulphate, and the mixture ground with water and leached. The solution, containing zinc, manganese, and sodium sulphates, is electrolyzed between anodes of lead and cathodes of zinc foil, manganese dioxide being deposited on the former, and pure zinc

on the latter. A current of 300 amp. per sq. m. of cathode surface is employed at $2\frac{1}{2}$ to $4\frac{1}{2}$ volts.

—Described in Jour. Soc. Chem. Ind., vol. 35, p. 54. Jan. 15, 1916.

- 1986a 481,816. Electrolytic separation of zinc from solution.—**Compagnie Bordelaise des Produits Chimiques.** Jan. 23, 1917.

An iron anode is used, and the cathode is not separated by a diaphragm.

- 1986b 481,832. Apparatus for extracting zinc from its minerals.—**L. Sturbelle.** Jan. 23, 1917.

"The construction of the apparatus is such, with respect to the disposition of the elements constituting the anode around the cathode, as to secure a uniform distribution of the current upon the cathode."—Chem. Abst.

Germany

- 1987 75,556. Anode of basic zinc salt.—**Hoefflich.** 1894.
—Described in Zeits. f. Elektrochem., vol. 1, pp. 138-39. July 15, 1894.

- 1988 84,579. Electrolytic recovery of zinc and chlorine from sulphide ores, roasted pyrites or other residues.—**E. Matthes and Weber.** Jan. 19, 1895.

- 1989 118,291. Electrolytic recovery of zinc from zinc ores and zinciferous residues.—**Julius Nothmann, Kattowitz, Silesia.** Oct. 1898.

See also item 1646.

—Described, with diag., in Zeits. f. angewandte Chem., vol. 14, pp. 346-47. April 2, 1901.

- 1990 118,676. Electrolytic recovery of zinc and other metals, using soluble metallic anodes.—**Societe des Piles Electriques, Paris.** Nov., 1899.

—Described with diag., in Zeits. f. angewandte Chem., vol. 14, p. 347. April 2, 1901.

- 1991 151,336. Process for the production of zinc or zinciferous precipitates by electrolysis.—**Emmanuel Goldberg, Moscow, Russia.** Feb. 13, 1902.

See also item 1696.

—Abstract. Zeits. f. angewandte Chem., vol. 17, p. 1216. Aug. 19, 1904.

- 1992 162,785. Process for the electrolytic recovery of zinc from sulphate solutions.—**Siemens and Halske.** Nov. 21, 1903.

Uses an anode of platinum or platinum alloy.

- Described in *Zeits. f. Electrochem.*, vol. 12, p. 74 Jan. 26, 1906.
- Described in *Zeits. f. angewandte Chem.*, vol. 18, p. 1865. Nov. 24, 1905.
- 1993 184,516. Process and apparatus for the electrolytic separation of zinc, magnesium and other metals, using mercury cathodes.—**Decker Mfg. Co.**, Wilmington, U. S. A.
- 1994 195,033. Process for the electrolytic recovery of metallic zinc in compact form by electrolyzing a solution of zinc sulphate without the use of a diaphragm.—**Siemens and Halske**, Berlin. Aug. 30, 1906.
- Described in *Zeits. f. angewandte Chem.*, vol. 21, p. 990. May 15, 1908.
- 1995 213,004. Process for removing iron from zinc sulphate solutions to be used for the electrolytic separation of zinc, by means of peroxides and zinc oxide.—**Siemens and Halske**, Berlin. April 12, 1908.
- “Manganese dioxide is used for the oxidation of the iron contained in zinc sulphate solutions, with a view to the subsequent precipitation of the iron with zinc oxide. The manganese dioxide is regenerated during the electrolytic separation of the zinc from the purified solution.”—J. S. C. I.
- Described in *Zeits. f. angewandte Chem.*, vol. 22, p. 2247. Nov. 12, 1909.
- 1996 233,252. Process for the electrolytic production of zinc from zinc pyrite cinders or other low-grade zinc-bearing raw materials, in which the raw material is leached out after a chloridizing roast.—**Siemens and Halske**, Berlin. Nov. 17, 1909.
- Described in *Zeits. f. angewandte Chem.*, vol. 24, p. 814. April 28, 1911.
- 1997 244,930. Process for the electrolytic separation of zinc, the electrolyte consisting of an aqueous solution of zinc fluoride, preferably in association with ammonium fluoride.—**Johann Matuschek**, Vienna, Austria. April 22, 1911.
- See also item 1695.
- Described in *Zeits. f. angewandte Chem.*, vol. 25, p. 983. May 10, 1912.
- 1998 267,531. Process for the recovery of zinc from ores, concentrates, residues, salts, or the like.—**Edgar A. Ashcroft**, Sogn, Norway. April 21, 1912.
- Electrolysis of chloride solution.
- Described in *Zeits. f. angewandte Chem.*, vol. 27, pt. II, p. 42. Jan. 16, 1914.

- 1999** 277,359. Regulating the circulation of the electrolyte in the electrodeposition of zinc.—**H. K. Borchgrewink** and **R. Molstad**, Christiania, Norway. Feb. 20, 1913.
—Described, with diag., in *Zeits. f. angewandte Chem.*, vol. 27, pt. II, p. 588. Oct. 23, 1914.
- 2000** 282,234. Process for making electrolytic zinc sponge compact.—**Griesheim-Elektron**, Griesheim, Germany. June 29, 1913.
See also item 1751.
- 2001** 285,652. Electrolytic process for the recovery of metals, as copper, zinc or nickel, from materials which contain the metal partly as oxide and partly as sulphide.—**Noak V. Hybinette**, Christiansand, Norway. Nov. 8, 1912.
—Described in *Zeits. f. angewandte Chem.*, vol. 28, pt. II, p. 434. Aug. 20, 1915.
See also item 1702.



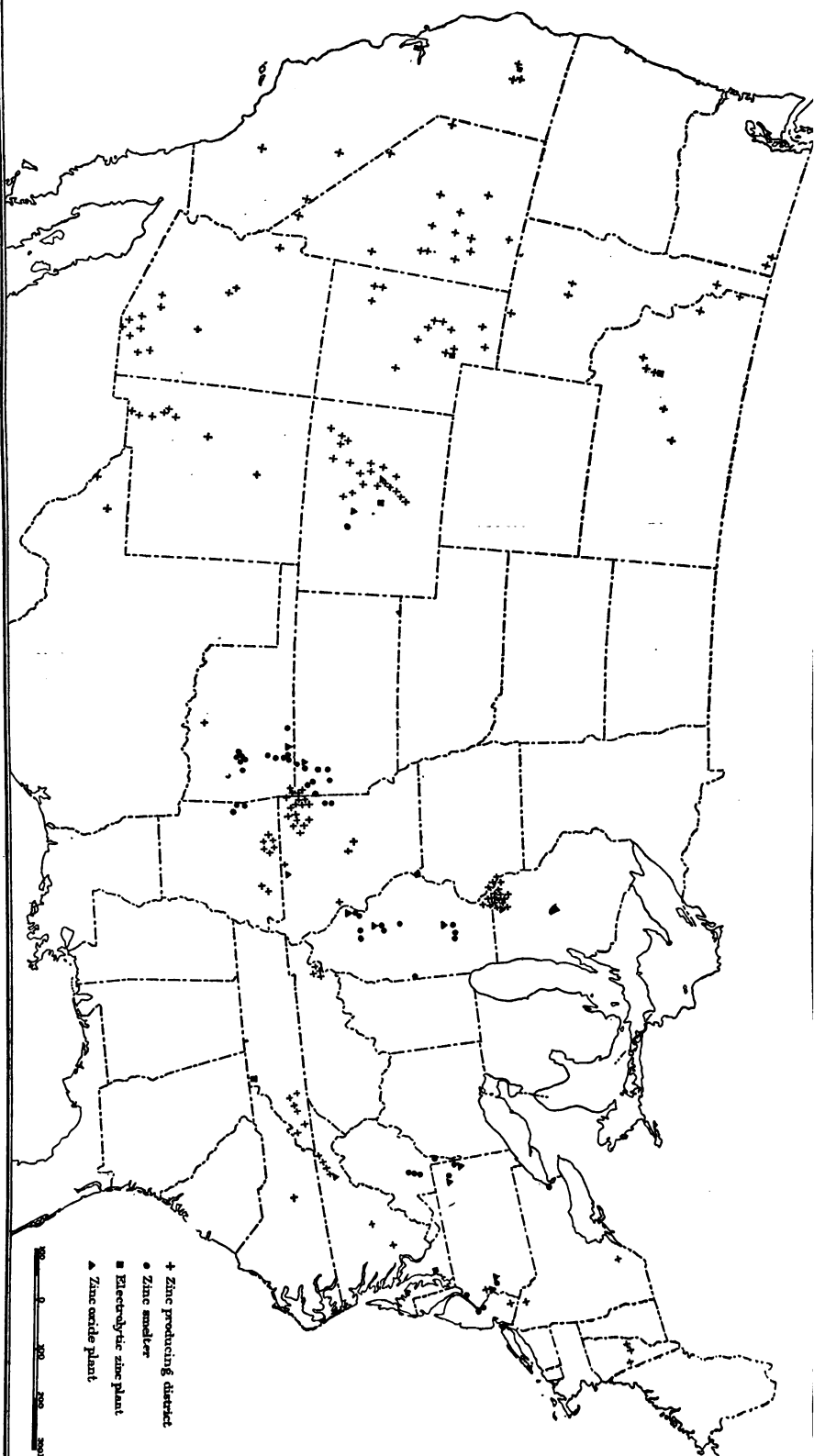
UNDERGROUND IN A ZINC MINE
Missouri-Kansas-Oklahoma District

SPELTER

- 2002** Analysis of spelter. Eng. & Min. Jour., vol. 100, pp. 439-40. Sept. 11, 1915.
 Abstract of report of committee of American Chemical Society.
- 2003** The behavior of heated zinc.—**James Scott.** illus. Metal Industry, vol. 4, pp. 138-39. 1912.
- 2004** Cadmium in spelter.—**W. R. Ingalls.** Eng. & Min. Jour., vol. 79, p. 697. April 13, 1905.
 —Abstract. Zeits. f. angewandte Chem., vol. 18, p. 1462. Sept. 8, 1905.
- 2005** Cadmium in spelter.—**W. R. Ingalls.** Jour. Inst. Metals, vol. 16, pp. 196-99. 1916.
 Deleterious effect of cadmium, especially in spelter destined for cartridge brass. Sampling of spelter.
 —Abstract. Min. Jour., vol. 114, p. 659. Sept. 30, 1916.
 —Abstract, with additional comments: Zinc and its common impurities. Min. Mag., vol. 15, pp. 239-40. Oct., 1916.
 —Abstract. Jour. Soc. Chem. Ind., vol. 35, p. 1020. Oct. 16, 1916.
- 2006** Cadmium in spelter. Eng. & Min. Jour., vol. 103, pp. 299-300. Feb. 17, 1917.
 Discussion of paper by W. R. Ingalls, above.
- 2007** Chemical analysis of spelter.—**A. M. Fairlie.** Metal Industry, vol. 2, pp. 350-51. Oct., 1910.
 Detailed description of the methods employed for the estimation of zinc and the common impurities in spelter.
 —Abstract. Jour. Inst. Metals, vol. 5, pp. 331-32. 1911.
- 2008** Comparison of granulated and drilled samples of spelter.—**E. M. Johnson.** West. Chem. & Met., vol. 6, pp. 201-4. June, 1910.
 Granulated sample shows slighter varieties in per cent of iron and lead than does drilled sample, and has other advantages.
- 2009** Grades and uses of spelter.—**G. C. Stone, W. H. Bassett and M. N. Price.** Iron Age, vol. 98, p. 86. July 13, 1916.
 The common impurities—aluminum, iron, lead, cadmium; the amounts allowable in different grades, and their effects on the spelter's properties.
 —Same. Min. Wld., vol. 45, pp. 287-88. Aug. 12, 1916.
 —Same. Eng. & Min. Jour., vol. 102, pp. 331-32. Aug. 19, 1916.

- Abstract, with additional comments. *Min. Mag.*, vol. 15, pp. 239-40. Oct., 1916.
- 2010 The kinds of spelter. *Eng. & Min. Jour.*, vol. 99, pp. 292-93. Feb. 6, 1915.
—Correction., p. 460. March 6, 1915.
- 2011 Physical and chemical properties of zinc. *Mineral Industry*, vol. 12, pp. 363-66. 1903.
Reduction temperature, specific heat, atmospheric action, etc.
- 2012 Prime western spelter. *Eng. & Min. Jour.*, vol. 86, p. 820. Oct. 24, 1908.
Editorial giving history of the term.
- 2013 The properties of spelter. *Eng. & Min. Jour.*, vol. 94, p. 146. July 27, 1912.
Editorial: certain spelters of apparently equivalent composition give different results in practice.
- 2014 Sampling of spelter. *Eng. & Min. Jour.*, vol. 102, p. 108. July 8, 1916.
Methods. See also next item.
- 2015 Sampling of spelter. *Eng. & Min. Jour.*, vol. 102, p. 358. Aug. 19, 1916.
Grades and sampling methods, as affected by price fluctuations.
- 2016 Spelter for high grade brass; report of zinc producers to the Committee on Raw Materials of the War Industries Board. *Metal Industry*, vol. 16, pp. 175-76. April, 1918.
- 2017 Spelter manufacture and properties.—**George C. Stone.**
Amer. Inst. Metals, Trans., vol. 8, pp. 174-95. 1914.
"Summary of the development of zinc metallurgy and review of the most representative zinc furnace designs." Discussion of impurities in spelter—iron, cadmium, arsenic, lead—their cause and effect.
—Same. *Min. & Sci. Press*, vol. 109, pp. 754-59. Nov. 14, 1914.
—Abstract. *Met. & Chem. Eng.*, vol. 12, p. 643. Oct., 1914.
—Abstract, in German. *Metall u. Erz.* vol. 12, pp. 9-11. Jan. 8, 1915.

MAP SHOWING THE ZINC INDUSTRY OF THE UNITED STATES
As of January, 1919



ACTIVE ZINC SMELTERS IN THE UNITED STATES

(Includes plants working on ore alone, on ore and drosses, and on drosses alone.)

(A—acid plant; not necessarily at the smelter.)	Operating company.	Location.	Retorts at close of 1915.	Retorts at close of 1916.	Retorts at close of 1918.
ARKANSAS.					
Arkansas Zinc & Smelting Corporation.....	Van Buren			3,200	3,200
Athletic Mining & Smelting Co.	Fort Smith .....			.....	2,496
Fort Smith Spelter Co.	do			2,560	2,560
COLORADO.					
United States Zinc Co.	Pueblo		2,208	1,984	8,256
ILLINOIS.					
American Zinc Co. of Illinois (A)	Hillsboro		4,000	4,864	4,864
Collinsville Zinc Smelter	Collinsville		1,792	2,304	<i>Idle</i>
Granby Mining & Smelting Co. (A)	East St. Louis		3,220	4,820	5,600
Hegeler Zinc Co. (A)	Danville		3,600	5,400	5,400
Illinois Zinc Co. (A)	Peru		4,640	4,640	5,320
Matthiesson & Hegeler Zinc Co. (A)	La Salle		6,168	6,168	6,168
Missouri Zinc Co.	Beckemeyer		352	352	352
Mineral Point Zinc Co. (A)	Depue		9,068	9,068	9,068
National Zinc Co. (A)	Springfield		3,200	4,480	4,480
Robert Lanyon Zinc & Acid Co. (A)	Hillsboro		1,840	3,200	3,200
Sandoval Zinc Co.	Sandoval		672	672	<i>Idle</i>
INDIANA.					
Grasselli Chemical Co.	Terre Haute		38,552	45,968	44,652
KANSAS.					
American Spelter Co.	Pittsburg		896	992	<i>Dismantled</i>
American Zinc, Lead & Smelting Co.	Caney		6,080	6,080	<i>leased</i>
Do	Dearing		4,480	4,480	<i>Dismantled</i>

Chanute Spelter Co.	Chanute	1,280	1,280	"
Cherokee Smelting Co.	Bruce	896	896	Idle
Edgar Zinc Co.	Cherryvale	4,800	4,800	4,984
Granby Mining & Smelting Co.	Neodesha	3,760	3,760	Dismantled
Iola Zinc Co.	Concreto	660	1,320	"
Joplin Ore & Spelter Corporation	Pittsburg	1,444	1,792	"
Lanyon Smelting Co. ....	.....do	448	448	Idle
Owen Zinc Co.	Caney	1,280	1,920	"
Pittsburg Zinc Co.	Pittsburg	910	910	"
Prime Western Smelter Co. (A)	Gas	4,868	4,868	2,320
United States Smelting Co.	Altoona	3,960	4,600	Dismantled
Do	Iola	3,440	3,440	Idle
Do	La Harpe	1,924	1,926	Dismantled
Weir Smelting Co.	Weir .....	.....	288	Idle
Do	Caney .....	.....	.....	4,352
MISSOURI.				
Edgar Zinc Co.	St. Louis	41,126	43,800	11,656
Missouri Zinc Smelting Co.	Rich Hill	2,000	2,000	Dismantled
Nevada Smelting Co.	Nevada	672	448	Idle
.....	.....	.....	672	"
OKLAHOMA.				
Bartlesville Zinc Co.	Bartlesville	2,672	3,120	.....
Do	Blackwell	5,184	6,336	6,336
Do	Collinsville .....	.....	9,600	9,600
Bartlesville Zinc Co. (Lanyon-Starr plant)	Bartlesville	10,752	13,440	Dismantled
Eagle-Picher Lead Co.	Henryetta	3,456	3,456	3,456
Henryetta Spelter Co. ....	.....do .....	.....	4,000	4,000
Kusa Spelter Co.	Kusa	3,720	3,000	3,000
National Zinc Co.	Bartlesville	4,970	7,720	5,630
Oklahoma Spelter Co.	Kusa .....	.....	4,970	4,970
Quinton Spelter Co.	Quinton .....	.....	1,600	Idle
.....	.....	.....	1,344	2,016

ACTIVE ZINC SMELTERS—Continued

Tulsa Fuel & Manufacturing Co.	Collinsville	6,232	6,232	6,232
United States Smelting Co.	Cherotah		5,120	<i>Idle</i>
United States Zinc Co.	Sand Springs	5,680	8,000	8,000
Western Spelter Co.	Henryetta		2,400	3,200
PENNSYLVANIA.				
		39,994	77,218	56,440
American Steel & Wire Co. (A)	Donora	3,648	9,120	9,120
American Zinc & Chemical Co. (A)	Langeloth	3,648	7,296	7,296
New Jersey Zinc Co. (of Pennsylvania)	Palmerston	6,720	7,200	7,192
WEST VIRGINIA.				
		14,016	23,616	23,608
Clarksburg Zinc Co.	Clarksburg	3,648	3,648	<i>Idle</i>
Grasselli Chemical Co. (A)	do	5,760	5,760	5,760
Do	Meadowbrook	8,592	8,544	8,520
United Zinc Smelting Corporation (A)	Moundsville			1,728
		18,000	17,952	16,008
PLANTS WITH SPECIAL RETORTS.*				
		156,568	219,418	167,028
Eastern Zinc Refining Co.	Brooklyn, N. Y.		8	16
John Finn Metal Works	San Francisco, Cal.		2	12
Michael Hayman & Co.	Buffalo, N. Y.	12	12	12
M. M. S. Metal Co.	Trenton, N. J.		21	<i>Dismantled</i>
Trenton Smelting & Refining Co.	do	96	96	80
William Cramp & Sons Ship & Engine Building Co.	Philadelphia, Pa.	32	32	<i>Dismantled</i>
Total large retorts		140	171	120

*Large graphite retorts yielding 600-800 pounds of spelter per charge.

ELECTROLYTIC ZINC PLANTS IN THE UNITED STATES, DECEMBER 31, 1918.

Company	Location of plant	Rated daily capacity	Remarks
American Smelting & Refining Co.....	Murray, Utah	Experimental.....	Operated in 1916; idle in 1917-18
Anaconda Copper Mining Co.	Great Falls, Mont.....	200 tons.....	Operated in 1917-18
Basin Salvage Co.,	Basin, Mont.....	Experimental.....	Operated in 1917
Butters Electrolytic Zinc Syndicate.....	Martinez, Cal.....	6 tons.....	Operated in 1918
Ducktown Sulphur, Copper & Iron Co.	Isabella, Tenn.....	1 ton.....	Under construction
Electrolytic Zinc Co.	Baltimore, Md.....	10 tons.....	Operated in 1917-18
Judge Mining & Smelting Co.....	Park City, Utah.....	15 tons.....	Operated in 1918
River Smelting & Refining Co.....	Keokuk, Iowa.....	20 tons.....	Operated in 1917-18
U. S. Smelting, Refining & Mining Co. (Mammoth)	Kennett, Cal.....	25 tons.....	Operated in 1917-18
Western Chemical Co.	Denver, Colo.....	10 tons.....	Under construction



ENTRANCE TO PARKER HALL AND LIBRARY

INDEX
of
Authors, Patentees and Subjects.

Numbers refer to items in the bibliography, not to pages. P before a number indicates that it refers to a patent or to an article about a patent.

The following abbreviations have been used: agt, agent; B.F., blast-furnace; chem., chemical; ppn, precipitation; ppt, precipitate; pptant, precipitant; smtg, smelting; zn, zinc.

- Abegg, F., 174, 178.
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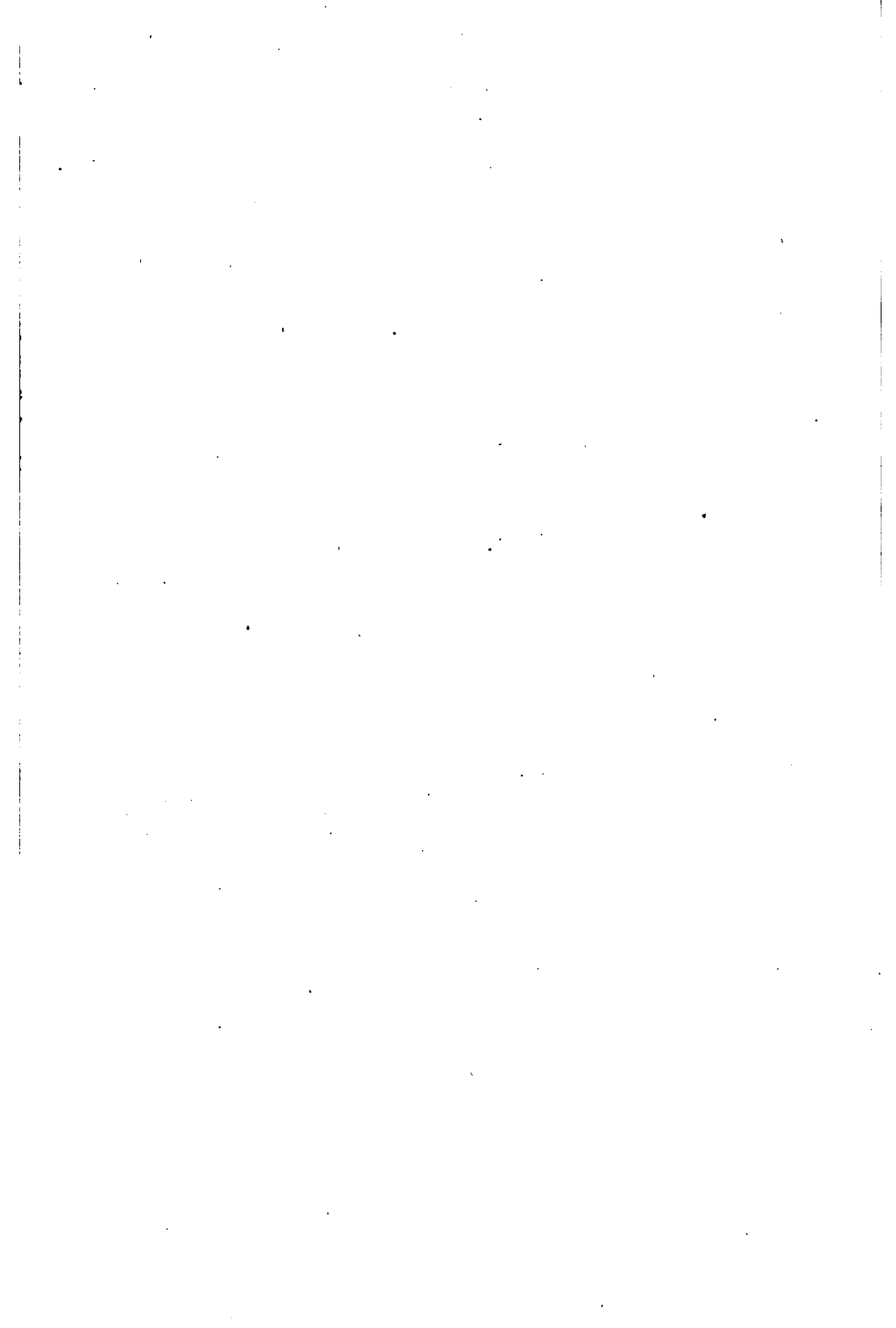
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